THE TUBERCULOSIS PROBLEM.

Some Observations on the Present-Day Outlook, with Special Reference to the Etiology, Epidemology, Prophylaxis and Treatment of Phthisis in the Western Highlands and the Isles.

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by

G. H. GUNN, M.B., D.P.H.,

Assistant Medical Officer of Health and

Tuberculosis Officer,

County of Argyll.

INTRODUCTION.

Fifty years ago, Hirsch declared his belief that Tuberculosis was a disease of all times and all countries, Of a truth the disease, as a clinical entity, can boast of a history dating back some two thousand years; at the present day its incidence is practically world-wide, yet it is questionable if the dictum of Hirsch is applicable to the disease as a social problem.

In those far-off days, when the pioneer peoples of Western civilization were shaping models of physical and mental perfectness which are still unsurpassed, it is probable that Tuberculosis occurred sporadically. That the disease first began to assume the epidemic proportions - which constitute it a social problem - somewhere about the beginning of the 17th century, is more than a matter of conjecture. The fact that, among certain nomadic tribes of the desert at the present day, Tuberculosis is unknown, leads to the assumption that - so long as the races of men lived a life in strict accordance with the dictates of Nature, - the disease made but little headway.

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The evolution of Tuberculosis from a sporadic malady to its culmination as the most destructive pandemic of modern times is, in great measure, the story of the assault upon Mankind of those pathogenic forces which go to swell the list of communal diseases of the present day. Through obedience to the gregarious habit and economic considerations of the first order, Mankind of the present day passes the tenure of existence surrounded by an environment utterly at variance with the injunctions of Nature. Once the balance of Nature is disturbed, swift compensation must follow. That that compensation has not been forthcoming in full measure is written large in the ethics of Man's susceptibility to germ-borne disease.

In the sphere of Western civilization, Tuberculosis appears to have been much later in asserting itself, than the fast-breeding epidemics of plague and cholera, which raged in the Middle Ages. The insidious nature of the spread of the disease probably explains the fact that the earliest reference to Tuberculosis as a social menace dates no further back than the seventeenth century.

The discovery of the causative organism - the Tubercle Bacillus - in 1882 by Robert Koch, marks the beginning of the modern conception of Tuberculosis as a social/

social problem. The demonstration of the essential infectivity of the disease - for which the world had waited centuries - ushered in a great renaissance in the study of Tuberculosis and laid the foundation of our present day system of prophylaxis and treatment.

Preventive Medicine - by which is meant the co-ordination of efforts to suppress disease on a national scale - has been little more than half-a-century in being. By the middle of last century, little or nothing had been done towards safeguarding the community at large against the inroads of infectious diseases. In London and some of the larger provincial centres, a system of death-registration and notification of cases of epidemic disease existed, but, taking the country as a whole, very little accurate knowledge regarding the prevalence and morbidity of such disease was obtainable.

The first step towards the inauguration of a national policy in regard to Preventive Medicine, was the institution in 1855 of National Registration of Deaths by Act of Parliament. Statistics thereafter accumulated from which it was possible to ascertain with exactitude, the actual and relative importance of the various causes of death, besides cognate information of the greatest value in the organization of preventive work.

Results/

Results were quick to follow. The first - a striking revelation of the enormous proportion of the total deaths which were due to preventible causes - gave rise to much pricking of the public conscience. In 1869 the Royal Sanitary Commission was appointed to enquire into and report on the various factors causing detriment to the public health. Three years later, the Local Government Board was formed and charged with the function of concerting and controlling measures directed towards improved public health and sanitation.

True, the immediate cause of the salutary procedure, was an epidemic of cholera which manifested itself in East Anglia at the time. But public opinion, generally, was ripe for the step.

Meanwhile the Royal Sanitary Commission continued its investigation of disease problems and after a session of six years submitted its Report to Parliament. The result was the passing of the Public Health Act of 1875. This Act embodied the recommendations of the Royal Sanitary Commission and laid the foundation of State Preventive Medicine. Dictated by needs as they arose, additional Acts and Regulations followed from time to time, amplifying the sanitary code. Compulsory Notification of the principal infectious diseases came into force twenty-three years before/

before similar provision was made in the case of tuberculosis by the Public Health (Tuberculosis) Regulations (1912).

No more eloquent testimony to the demands made by the progress of civilization upon Preventive Medicine can be cited, than the imposing list of Acts and Regulations pertaining to the social problems of communicable disease. Social conditions have undergone a metamorphosis in the space of a Century. Generations yet unborn will point to the nineteenth century as an age of discovery, development and progress unexampled in the whole story of civilization. Outstanding as a factor in the evolution of modern society, the phenominal rise of Industrialism dwarfs by comparison, any other combination of social movements which have rendered the constitution of society very different from that of a hundred years ago. Consequent upon the growth and centralization of industry, the population has migrated from rural to urban centres, so that from being, in the beginning of the century, mainly a pastoral community, the bulk of the population is now to be found in the cities.

Needless to say, in the absence of a national health policy for three-quarters of the period, the safe-guarding of the health of the industrial population lagged/

lagged far behind the necessity for such action. As a result, the social conditions of the worker, both at home and in the factory, were often deplorably unhealthy. Foreign commitments and exploitation of colonial resources involved the question of the control of such tropical diseases as Malaria, plague, yellow fever, etc. These and other economic factors combined to create the necessity for a State-controlled system of Disease prevention. Nor, when the necessity became apparent, were the means found wanting. Medical science progressed pari passu with the advance in technical sciences. It is not possible in this paper to do more than allude to the brilliant achievements in the field of medical and allied research, which have made practicable the evolution of a rational policy of Preventive Medicine.

Modern times have been remarkable for the expansion of the policy of State Medicine no less than for a complete vindication of the principle involved. It goes without question that the control of epidemic or infectious disease takes its place legitimately within the sphere of civic administration, notwithstanding that but a brief retrospect of its working is yet available. Ill-advised and ill-concerted measures, no matter how laudably conceived, can only, in the absence of/

of a central authority, defeat their own ends. The merging of local authorities for the purpose of public health administration, though yet far from complete, especially in scattered rural areas, has everything to commend it in the way of beneficial results. The chief controlling Health Authorities in Great Britain merged three years ago (1918) into a Department of State, the Ministry of Health.

The period of the Great War (1914-21) occasioned an abnormal interest in contemporary health problems. The attrition of man-power resulting from the colossal casualties incurred during hostilities, focussed public attention upon the question of the national standard of health with an intensity never previously witnessed. The ethics of national health problems came to be studied with the zeal born of desperate emergency. To many, it came as a surprise to discover the wastage of human material that resulted from the prevalence of preventable diseases; to all came the conviction that the conservation of national health should no longer rank as a subsidiary factor in political economy.

Paradoxically enough, the hour of realization finds the moment of opportunity gone, and post-war development of health measures, housing schemes and the like/

like, finds itself curtailed or postponed indefinitely through the economic depression which has paralysed progress in other spheres of national activity.

To-day the spirit of economy is abroad, and the utility of many national institutions is being subjected to trenchant scrutiny. The acid test of efficiency is being applied to departmental administration, and whatever the outcome may be, it is certain that the Health services will be curtailed to the absolute minimum consistent with expediency. The Minister of Health, Dr. Addison, states that for the current year, 1921, a sum of £125,000 was voted for the purpose of carrying on medical research. When one reflects that the ten millions recently voted to supplement the falling wage of the coal-miners, represent a sum equal to an eighty years' accumulation of the present Treasury grant for research purposes, one is forcibly struck by the paucity of support accorded to our first line of defence against epidemic disease.

The moment, therefore, would appear to be opportune for a brief retrospect of the Tuberculosis Problem in general, and in particular, of those features which it represents in the area selected for consideration.

No limits can be set to the territorial distribution of/

of Tuberculosis. Primarily, a disease affecting white races it has followed in the wake of European traders and settlers, until at the present day, practically no shade or sect of humanity is immune from its ravages. It is endemic amongst white men wherever situated; it devastates whole villages on the Congo and Zambesi; it is one of the chief causes of the gradual extinction of the aborigines of North America and Australasia. Its virulence is little affected by variations in temperature or climatic conditions generally. It is no respecter either of person or class; it may be met with in the palace of the merchant prince or in the clachan of the Highland shepherd. Nor does it confine its attack to the constitutionally weak - as often as not, it strikes down the strong man in the full flush of his manhood, whilst not unfrequently it occurs as an intercurrent infection in the course of a debilitating illness.

Besides being a potent killer and fruitful source of incapacitating sickness among adults Tuberculosis causes an enormous amount of disease in children, which may be followed by permanent deformity or loss of function of the parts involved.

Tuberculosis, inasmuch as it causes loss of valuable lives and an incalculable amount of damage to/

to health, constitutes a factor in public economics with which practically every modern community is faced.

In the British Isles, the disease has been endemic for centuries. The Registrar-General's Returns show that the death-rate from phthisis has been steadily declining, in England since 1838 and in Scotland since 1870. In the year 1855, when these returns first became available for Scotland, 10,007 deaths from all forms of Tuberculosis occurred, 7,129 of which were caused by phthisis. During the succeeding fifteen years, the number of deaths steadily rose, until in 1870, the maximum figures were recorded - 13,027 due to all forms and 9,148 due to phthisis. In the year 1919, the latest year for which statistics are available the number of deaths caused by all forms in Scotland was 6,326 - the minimum since the institution of National Registration. In England and Wales, however, the minimum was reached in 1913, since when there has been a steady rise in mortality especially amongst women, and due, doubtless, to the abnormal conditions of life and work during war-time.

As compared with the 1870 maximum for Scotland, the number of deaths from tuberculosis for 1919 is 51.4 per cent. less. In 1870 and 1871, the deaths from/

from Tuberculous diseases numbered over 13,000 annually; in the decennium 1872-83 constantly more than 11,000; this number fell below 10,000 in 1888, below 9,000 in 1910, below 8,000 in 1914 and for the first time below 7,000 in the year 1919.

The death-rate from pulmonary tuberculosis was 88 per 100,000 in 1919, which is 19 less than that of the previous year, 18 less than the mean of the previous five years and 23 less than the mean of the ten preceding years. In 1870 and 1860 this death-rate was 283 per 100,000 so that the phthisis death-rate for 1919 is less than a third of what it was in those two years.

The decline in the death-rate from phthisis will be discussed more fully at a later stage. At the moment, it is appropriate to observe, that despite the considerable fall that has already taken place, no less than 8.4 per cent. of the total deaths from all causes, and 55.4 per cent. of the total deaths attributed to the principal epidemic diseases (including Tuberculosis) were caused by all forms of Tuberculosis in Scotland during 1919. This example serves to emphasize the magnitude and importance of the disease as an economic problem.

In this connection, a comparison between the morbidity/

morbidity of the chief preventible diseases and Tuberculosis, will be found illuminating.

TABLE I - Scotland, 1919.

Number of Deaths from:-	
Measles	899
Whooping Cough	1573
Diarrhoea	1569
Enteric Fever	83
Diphtheria	727
Scarlet Fever	222
Typhus	8
	5081
Pulmonary Phthisis	4294
All other Tuberculosis Disease	2032
	6326

Thus Tuberculosis Diseases in 1919 caused 63 deaths for every 50 caused by the aggregate of the chief acute infectious diseases. These latter claim the majority of their victims under the age of 10, whereas Pulmonary Phthisis - which accounts for more than two-thirds of the mortality from all tuberculosis diseases - attacks chiefly adults at the working age of life. The following table is important in this connection:-

TABLE II/

TABLE II - Scotland, 1919.

Out of every 100 deaths at all ages, the number occurring at different ages from each Cause of Death was:-

	Under 15	15 - 45	45 - 65	65 -
Measles	96.99	2.79	.22	-
Whooping Cough	99.74	.26	-	-
Phthisis	7.91	67.53	21.47	3.09

Thus 97 out of every 100 total deaths from Measles and 99 out of every 100 total deaths from Whooping-Cough occurred under 15 years of age, while only 8 out of 100 deaths from phthisis occurred under this age; and during the adult and working years of life (15-45, 45-65) 89 occurred out of every 100 total deaths from phthisis as against 3 deaths from measles and slightly over one quarter per cent. of the total deaths from Whooping-Cough.

Evidently none of these diseases can equal Tuberculosis in importance. In addition to the fact that 9 out of every 10 deaths caused by the disease occur between the ages 15-65, it has to be borne/

borne in mind that Tuberculosis is responsible for a large proportion of the total incapacitating sickness occurring among adults in that age-group. The economic importance of Tuberculosis must therefore be considered, not only in the light of its morbidity, but also because of its inhibition of earning capacity. Broadly speaking, every individual has a certain economic value, which is zero - or potential only - at birth, and increases as age advances, becoming a positive value when he reaches the full exercise of his productive powers. During his years of helplessness in childhood, each individual has expended upon him, in the form of upbringing and education, a definite amount of time, money and effort - all of which may be regarded as so much capital invested with the prospect of future return. Should death occur in infancy, the actual economic loss is small, but if death occurs at later stages, that loss increases in direct proportion to the age at which death takes place. By the time the average individual has reached the age of 20, he had already received his education - and if earning wages, merely earns enough to balance personal expenditure. As an investment, he is so far unprofitable inasmuch as he has declared no dividends. Death at this age, therefore entails/

entails a serious loss of capital expenditure. After this age, the problem becomes more complicated. The individual assumes the higher duties and responsibilities of citizenship - he marries and sets up a home. By so doing, he incurs further liabilities before the debit balance carried over from his previous maintenance can possibly have been made good. It is during the ages 20-65 and especially 20-55 that the worker can hope to achieve economic solvency in the sense of returning the value of his own early maintenance and training. This he does, not by refunding the principal invested, to the original depositors, but, by personal saving and investing capital in the form of a home and the upbringing of a family in his turn. In this way only does he become a sound investment. The cycle of human economics is completed when the individual in return for his early guardianship - brings up a family until they are able to look after themselves - and further, has enough left over to provide for himself and his wife in their old age. This is the ideal sequence - but two postulates must be fulfilled if the worker is to attain it, to wit survival, and freedom from incapacitating illness. In regard to the first postulate, the significance of the fact that 9 out of every 10 deaths from/

from Phthisis occur in the age-group 15-65, is at once apparent.

In regard to the second desideratum, it is a matter of some difficulty to arrive at an accurate conception of the amount of total sickness caused by Tuberculosis. Notification of illness has not yet reached the stage of practical politics so that recourse must be had to the partial information available from the returns of Insurance Societies and similar organizations. It has been calculated from the statistics of two Societies, the Foresters and Oddfellows, that Phthisis causes approximately one-fifth of the total deaths from all causes, between the ages of 15 and 65. Now, as Phthisis is very often a chronic disease and in the majority of cases, causes death after a prolonged disablement, it is almost certain that it causes a higher proportion of the total sickness than of the total mortality. During the five years 1893-1897, the expense to the Oddfellows of sick-relief and death-benefit for which Phthisis was responsible, amounted to half-a-million sterling, while the loss of wages to the men themselves totalled at least twice that sum. The report of the Prudential Insurance Company of America in 1901 states that the annual cost of deaths from/

from Tubercular Diseases among its members, was approximately $800,000, and that "at the ages of most importance for Industrial insurance purposes, almost one-half of the entire mortality is due to consumption." (Newsholme). Dr. Hermann Biggs states that in 1903, his estimation of the expense of Tuberculosis to the people of the United States was $330,000,000 annually. In reports of the National Association for the Prevention of Tuberculosis it is estimated that one-eleventh of the total cost incurred in the relief of pauperism in England and Wales is caused by consumption, and that for the year ending Ladyday 1907, £14,035,888 was spent on Poor-Law administration. It is reckoned that, calculated on this basis, considerably over one million pounds are spent annually in England and Wales on paupers who were made such by consumption.

Dr. Addison, Minister of Health, states that in 1920 Tuberculosis services alone cost £1,900,000, which brings the total cost of Tuberculosis in England and Wales to nearly three million annually. Some interesting speculations arise from a study of the benefits which would accrue from the elimination of Phthisis from the community. In the first place, judging from the statistics for 1891-1900 in England and/

and Wales, the mean expectation of life of every male aged 15 would be increased by 2.8 years and that of every male aged 25 by 2.3 years. Interpreted in financial terms, the gain represented by this increase for all males aged 15-25 at the census of 1901, is reckoned to amount to some £400,000,000, or almost 10 millions annually. These figures make no allowance for prolonged illness, or for the further loss from the premature death of women from the same cause.

The malevolent influence of Tuberculosis is not confined to the sphere of national economy. The disease figures with equal importance in the depreciation of national efficiency. A striking example is afforded by the experience met with in the examination of recruits for service with the colours during the last two years of the Great War. Owing to the higher standard of physical fitness required for military service, the number of men found unsuitable on account of Tuberculosis or its effects, far exceeded the proportion which would have been unfit to undertake useful occupations in civil life. At such a critical period of our national life - when Man-power spelt efficiency, and efficiency meant victory - or the converse, defeat - how fraught with/

with significance the fact that, at least two full-strength Army Divisions were lost annually to the country through the ravages of Tuberculosis!

The evidence afforded by statistics can leave us no doubt as to the importance of Tuberculosis as a factor operating to the detriment of communal welfare. A somewhat similar position with regard to the problem exists in the majority of European countries and in the United States of America. It will now be found appropriate to discuss, more intimately, the basic elements of the problem and the principles underlying our modern system of treatment and prevention.

HISTORICAL OUTLINE.

As in the case of other communal diseases, a rational system of prophylaxis against Tuberculosis must be founded upon a true understanding of the essential pathogenesis, etiology and epidemiology of the disease. It must be admitted at once that our knowledge of many aspects of the tuberculosis problem is woefully incomplete, notwithstanding the enormous amount of research-work which has and is being done on the subject. The fact that, according to Bulloch, 25,000 articles were written on Tuberculosis during the years 1893-1913 gives some idea of the complexity and diversity of the problems involved. Scientific research, triumphant in many fields, has been held up time and again in its assault upon the stronghold of Tuberculosis. The scope of the paper permits only of the briefest reference to the landmarks in the history of tuberculosis and to a summary of our present knowledge of the disease.

The history of phthisis as a recognised disease is older than that of the Christian Era by a good 400 years. Hippocrates, the "father of Medicine" was well acquainted with/

with its symptomatology and Galen was convinced of its contagious nature. The tendency of phthisis to spread by contagion was recorded by Avicenna, an Arabian physician in 1037 A.D. Valsalva and Morgagni, in the 17th century, objected to the performance of post mortem examinations on consumptives on account of the danger of infection. In 1782 the city of Naples enforced a law for the isolation of consumptives and the disinfection of their houses and belongings. Thus the infectivity of Tuberculosis was recognized from the earliest times, although not demonstrated until half-a-century ago.

The pathology of the tuberculous lesion lay under obscurity until Koch's epic discovery threw the welcome light of day upon the origin and nature of the tuberculous process. The Hippocratic conception of phthisis as an ulceration and suppuration of the lungs dominated medical opinion for well-nigh two thousand years. Aretaeus (circa 150 A.D.) removed one fallacy by differentiating empyema from phthisis. It was not until the 17th century, however, when anatomical examination of the dead came into vogue, that progress was made in the right direction. Sylvius (1614-1672) stated that tubercles were often found in the lungs in cases of consumption and that they softened and suppurated to form vomicae. He/

He surmised that tubercles were merely enlarged glands, which had swollen on account of the accumulation of viscid humours or secretions, derived from the bile, saliva or pancreatic juice, acting through the blood. In these, the dark ages of medical science, body "humours" were held to be the "fons et origo" of all diseases.

A great advance, however, was made by Richard Morton, who states in his Phthisiologica that consumption "is a universal wasting of the parts of the body caused by some distemper of the lungs, as a stuffing, swelling, inflammation and ex-ulceration of them, and thereupon it is attended by a cough, difficulty of breathing and other symptoms of the chest, and accompanied by a fever, which is at first slow and hectical, after inflammatory, and at last, putrid and intermitting." The value of Morton's work lay in his insistence upon the presence of tubercles in the lungs in every case of phthisis. Bonetus described cavities and the caseous nature of tubercles and Mangetus in 1700 described a case of generalized miliary tuberculosis. Desault in 1733 rejected the theory of ulceration of the lungs as the essential cause of phthisis and ascribed the contagion of the disease as being due to the presence of worms. If one substitutes microbes for worms, this description could not be improved upon at the present day.

Matthew/

Matthew Baillie, at the end of the 18th century, gave it as his view that tubercles arose in the cellular tissue of the lungs and were not glandular in origin, as Sylvius had supposed. Baillie, and later Bayle, assumed a close connection between Scrofula and tubercle, and Bayle was the first to use the word Tuberculosis," and further was the originator of the belief in a tuberculous diathesis. He held that the tuberculous diathesis or disposition, was the essential cause of tuberculous phthisis.

Some fifty years later, the views of Laennec ushered in a new era in the pathological conception of tuberculosis. Laennec proclaimed the doctrine of the essential unity of phthisis. All phthisis, he stated, was tuberculous. He described miliary tubercles and Bayle's granulations and showed that transitional forms connect the two. He believed that "Inflammation plays no part in the formation of tubercles. Scrofulous glands are tuberculous. Haemoptysis is not the cause, but always the result of phthisis. Tubercle, wherever situated, is connected with a certain disposition, but the real cause, like that of all diseases, is probably out of our reach." These were great words, which dealt the death-blow to the Hippocratic theory that phthisis was caused by an unresolved pneumonia, a haemoptysis, or/

or a suppuration of the pleura. Broussais and Andral opposed Laennec's views, but these views were finally accepted generally in England and France, though not in Germany.

It has to be borne in mind that up to this time, views on pathology were based entirely upon naked eye observations. In the middle of last century, however, the microscope was impressed into use for the minute examination of diseased tissue. The first result of the minute study of the tuberculous lesion was the enunciation of some daring hypotheses as to the nature and causation of phthisis. In 1844, Lebert described distinctive tubercle corpuscles in the tubercles, which according to Addison and Reinhardt were derived from the blood. The dualist theory postulated that most of the tuberculous lesions were not due to tubercles, but to inflammation, which gave rise to the tubercles as a secondary process. Virchow in 1852, did more to shake the belief in Laennec's doctrine of the unity of phthisis, by declaring that tuberculosis was not a specific process. He limited the term "tubercle" to miliary tubercles, which he described as neoplasms which subsequently undergo caseation, and calcification or softening and absorption. His views obtained credence in Germany/

Germany, but not in Britain or France.

The first experimental evidence in support of the theory of infectivity of tuberculosis was brought forward by Klencke in 1843. He was successful in producing widespread tuberculosis of lungs and liver in rabbits by injecting tubercle cells taken from miliary tubercles into the jugular vein. In 1857, Buhl first advanced the hypothesis that tuberculosis was a specific infection of the blood originating in a caseous focus in a lymphatic gland in some part of the body. This pronouncement constitutes a landmark in the history of phthisis, as it is the first attempt to explain the disease on the basis of infection. Seven years later, the brilliant research work of Villemin demonstrated the essential connection between the virus causing the disease and the lesions produced by it.

The experiments of Villemin were published in 1865. He inoculated rabbits with matter taken from grey and yellow human tubercles and found that

1. animals thus inoculated developed pulmonary tuberculosis,
2. control animals which had not been so inoculated remained free from tubercle,
3. other animals similarly inoculated with pus from non-tuberculous patients did not develop tuberculosis.

Some time later he produced experimental Tuberculosis by inoculating/

inoculating animals with caseous material from a variety of tuberculous lesions, with the sputum of consumptives and tuberculous material from a cow. In a note to the Academie de Medecine, Villemin summed up his results in the following words:-

"1. Tuberculosis is the effect of a specific causal agent, in short, a virus.

2. This agent must reside like its congeners, in the morbid products formed by its direct action on normal elements of the affected tissues.

3. Introduced into an organism susceptible to its action, it must continue to reproduce itself, and at the same time to reproduce the disease of which it is the essential principle and determining cause. Experiment has confirmed the results of induction."

The conclusions arrived at by Villemin entail more than the mere proof that tuberculosis is an infectious disease; it argues strongly against the existence of a special tuberculous diathesis - a factor which was held at that time to be of prime etiological importance. A sharp controversy then ensued regarding the specific nature of the tuberculous contagion. H. Martin showed that nodules produced by foreign bodies were not inoculable in other animals, whereas true tubercles were re-inoculable without diminution in virulence. Cohnheim, originally opposed to the contention of specificity, changed his views as a result of his beautiful experiment of inoculating animals/

animals in the anterior chamber of the eye. By this means he was able not only to establish specificity, but also to study each stage in the evolution of tuberculosis of the iris and cornea.

At this juncture it is fitting to pay meet tribute to the pioneer work of Laennec, Villemin, Cohnheim and others, which advanced the knowledge of tuberculous pathogenesis to its penultimate stage. Step by step, progress had been made in face of difficulties and opposition of which not the least took origin from the tradition-ridden opinion of influential medical contemporaries. But one thing remained to be done to complete the chain of evidence in favour of the specificity of tuberculous contagion, to wit, the identification of the essential causative agent.

The theory of the bacterial origin of disease advanced at this time by Pasteur made it likely that the causal agent was bacterial in nature. It was found that the basic aniline dyes had a selective affinity for bacteria, but repeated efforts to find organisms in tuberculous tissues by their use met with failure. Robert Koch increased the efficacy of the stain by adding a mordant consisting of a quantity of alkali. In 1882, by use of his improved stain, Koch was able to detect the bacillus of tuberculosis and describe its morphological characters.

Koch's/

Koch's epic discovery formed a fitting climax to the brilliant research work of Villemin and Pasteur, and set the seal of probity upon the theory of specific origin of the disease which was enunciated by them. His further researches included the isolation of the tubercle bacillus, its cultivation outside the human body and demonstration of its capacity of "breeding true" on consecutive inoculation into different animals. He also succeeded in demonstrating the presence of the bacillus in all known tuberculous lesions and in the expectoration of consumptives.

ETIOLOGY AND PATHOGENESIS.

The morphological and cultural characteristics of the B. Tuberculosis are too well known to call for description here, but it is worthy of mention that certain of its biological properties are still in the process of elucidation. Considerable speculation has arisen over the possibly identity or commutability of the three main types of tubercle bacilli, the human, bovine and avian. Koch was of the opinion that the bovine bacilli were not at all identical with the human, and that they were not pathogenic to man. The Royal Commission on Tuberculosis (1905) gave its opinion that though transmutation of bacillary types is probably impracticable by laboratory methods, there is some evidence to show that under the conditions obtaining in nature or in human soil, transmutation of type may occur.

The question is one of special interest in view of the well-known pathogenicity of the bovine bacillus for man. Park and Krumwiede found that in adults of 16 years and over, 0.4 per cent. of pulmonary tuberculosis and 20 per cent. of tuberculosis of skin and abdominal organs were due to the bovine type. In children under 5 years of age/

age, 61 per cent. of cervical adenitis, 58 per cent. of generalized tubercle and meningitis of alimentary origin were caused by bovine bacilli. In Edinburgh, Mitchell found that 90 per cent. of cervical gland tuberculosis in children under 12 were due to the same variety. Children under five years show a marked pre-disposition to infection by the bovine Tubercle Bacillus, whereas the occurrence of bovine infection in adults is so negligible as to warrant the inference that adults are practically immune to infection by bovine bacilli.

In the vast majority of cases, pulmonary tuberculosis is due to the human type of bacillus derived from the subject of chronic phthisis, who contaminates his immediate surroundings with infective material brought up in the act of coughing or expectorating. Millions of virulent bacilli may be disseminated in this way by a single patient in the course of a day. Often the immediate environment of the sufferer is only too well suited to the retention of virulence of the infection. Overcrowding, deficient ventilation, lighting and cleanliness so frequent in those slum areas where tuberculosis is rife provide the optimum conditions for the acquirement of the infection by man.

The experience of half a century has made it abundantly clear that infection in phthisis is an intimate process, involving/

involving the close proximity of donor and recipient. In the human family, the infection, once acquired, takes up an almost unassailable position. An endo-parasite in the strictest sense, it may lie latent for years before reasserting its virulence in yet another member of the family circle. The classical fallacy of "hereditary" consumption admits of a rational interpretation when the fact is recognised that tuberculous infection, if not as the blood that flows in its victims' veins, is certainly as the air they breathe.

MODES OF INFECTION.

The transmission of infection is a feature of outstanding importance in the etiology of microbial disease - more particularly so in phthisis inasmuch as the causative organism is known to occur with such frequency in human environment. A vast amount of research has been directed towards the elucidation of the problems concerned with the modes of dissemination and portals of entry of the tubercle bacillus. Space forbids more than a cursory allusion to the experimental evidence accumulated by many noted investigators. At the outset, workers on the subject were faced with the difficulty - nay, often impossibility - of adequately reproducing natural conditions in the technique of research operations, with the result that returns were inaccurate. Conclusions arrived at being dissimilar, theories were advanced which were often diametrically opposed. Lack of uniformity in technique, type of laboratory animal used and so on doubtless contributed to the wide divergence of views enunciated by eminent authorities, so that the present state of our knowledge of the subject must not be regarded as final.

Searching/

Searching for a medium that might be found responsible for dissemination of the infection, Koch and Cornet found that dessicated tuberculous sputum was highly infectious to guinea-pigs. They therefore concluded that the germ-laden dust of dried-up sputum was the chief source of infection in man. Flügge largely discredited this view by pointing out that the conditions under which Cornet's experiment was conducted bore little, if any, analogy to the conditions actually obtaining in human dwellings. Kohlisch found that he could not infect guinea-pigs - a species highly susceptible to tubercle infection - with dust collected in houses occupied by consumptives. Wagner of Zurich and Chaussé of Paris showed that the dust collected from tuberculosis wards and consumptives' dwellings seldom harboured virulent bacilli. Fishberg states that bacilli contained in sputum quickly lose their virulence on account of the putrefactive and fermentative processes which occur readily on the flooring and walls of dark, badly-kept dwellings.

Flügge conducted experiments so devised as to approach, as nearly as possible, the conditions found in the houses of consumptives, and concluded that the greatest danger lay in "droplets" coughed up by the consumptive. Those droplets of mucous secretion from bronchiole or alveolus were frequently/

quently found to contain virulent tubercle bacilli. Heymann showed that such droplets are capable of propagation a distance of three feet. The ordinary, quiet respiration of a consumptive was found to be germ-free, but Laschtschenko showed that germs may be expelled from the mouth during the act of speaking and carried to the various corners of a room by means of air-currents.

The foregoing experiments appear to justify the belief that, as a medium of infection in phthisis, germ-containing "droplets" are of greater importance than the dried-up particles of infected sputum.

As already indicated, the part played by an infected milk-supply in the causation of tuberculosis is by no means inconsiderable. Estimates vary regarding the extent of bovine infection occurring in milk, different authorities alleging the presence of virulent infection in from 12 to 30 per cent. of samples. Recent research tends to detract from the importance formerly accorded to milk-borne infection. The question will be more suitably discussed in connection with the consideration of the portals of entry of infection.

Tubercle bacilli may gain an entrance into the human organism in three different ways, by Inhalation through the respiratory tract, by Ingestion through the alimentary tract/

tract, and by inoculation through the skin surface. The last is the least important. In adults, infection through a skin abrasion is usually followed by a mild local reaction, of which the well-known "pathologist's wart" is a useful example. I have met with but two clinical examples of inoculation-infection, both taking the form of a slowly progressive synovitis of the palmar tendons. In children, however, a fatal bacteraemia may develop. A classical example is seen in the occasional occurrence of acute miliary or generalized tuberculosis in Jewish infants infected locally during the rite of circumcision.

Entrance of the bacilli by the respiratory tract is held to occur through a breach in the mucous lining of the nasal passages, bronchi, or pulmonary air-vesicles. Similarly, any part of the alimentary tract from mouth to rectum may provide a means of entry for the bacilli - more particularly the gums, faucial tonsil and small intestine.

In dealing with infection through the respiratory tract, it is well to remember that Nature has provided the air passages with a strong natural barrier against bacillary invasion. The nasal passages, mouth and pharynx act as filters which detain inhaled dust or micro-organisms from entry to the deeper passages. Should dust or germs reach the bronchioles, however, the ciliated epithelium and mucus secreted/

secreted all along the tract tends to arrest the invaders and expel them as foreign bodies. Still further, when the remaining bacilli do gain access to the sub-epithelial layer, the extensive network of lymphatic vessels and apparatus effectively deal with the bacilli, destroying them or rendering them innocuous.

It must be conceded, however, that the filtrating effect of the respiratory mucous membranes and the "vital" action of lymphatic tissues are liable to break down under the strain of excessive activity. It is a well-known fact that long-continued exposure to dust-laden atmosphere gives rise to accumulation of dust in the lymphatic and interstitial tissues of the lung, as seen in the pneumokonioses.

By analogy, it is conceivable that, in cases of "mass" infection, an entrance may be effected by the tubercle bacilli through sheer incapacity of the local protective mechanism to cope with the invasion. The increased incidence of phthisis following the infective fevers provide an instance where the glands, overcome by the stress of a double infection, fail to arrest the entrance of the virus of tubercle. Then again, the mucosa and its subjacent lymphatic apparatus, which forms the first line of defence against microbic invasion, may have its function impaired by the action of external agencies. Cobbett mentions a case/

case in point as occurring in the lower animals. He observed bacilli of the coli group in the organs, especially the livers, of grouse in the caeca of which large numbers of the strongilus Pergracilis were found. The coli infection he considers is due to the sharp extremities of the nematodes puncturing the mucous membrane of the intestine and allowing of the entrance of B. Coli to the portal circulation. This theory is supported by the observation that B. Coli were constantly present in the livers, and elsewhere, of rabbits suffering from coccidiosis of the intestine. From these examples, Cobbett thinks that with reference to human mucous membranes, some agents may be present in the lungs to cause damage to the mucosa, and considers these may be found in "sharp spicules of steel and stone entering the lungs in the form of dust."

Interest deepens in this fascinating hypothesis when regard is had to the familiar fact that the incidence of phthisis amongst the sufferers from the industrial diseases, silicosis and siderosis, is remarkably high. It is nothing damaging to Cobbett's theory to point to the absence of phthisical tendency in workmen affected with anthracosis, inasmuch as the carbon particles causing this disease, are soft and by comparison, innocuous to mucous surfaces.

Some/

Some recent work by Cobbett affords valuable evidence in favour of the Inhalation theory.

Repeating some experiments of Harth and Hermann on infection by inhalation, and using the B. Prodigiosus, he showed that the organism could be demonstrated in the lungs of a guinea-pig killed so soon after the commencement of exposure to a fine spray of liquid containing the bacilli that no time was allowed for the absorption of the bacilli into the lymphatics and thence to the lungs. But the most important part of his work dealt with pulmonary infection during feeding. Suspecting that this occurred during some experiments performed for the Royal Commission on Tuberculosis, he fed rabbits and guinea-pigs, both young and old, on cultures of the B. Prodigiosus, made up into a thick suspension in milk. The material was put into the mouth of the animal either drop by drop with a platinum loop or spread upon lettuce leaves. The animals were killed within ten or fifteen minutes and the bacillus prodigiosus was constantly found in small numbers in cultures made from the lungs.

Cobbett states specifically: "We took every precaution to prevent anything unnatural which might cause the entry of bacteria into the bronchi." Everything causing forcible respiration was avoided; the animals were killed by/

by a special method to avoid entry of the bacilli into the lungs during the death-struggle.

These experiments discredit those of Calmette and Whitla, but as Cobbett carefully points out, they do not mean that the inhalation of tubercle bacilli means pulmonary or general tuberculosis in every case. They show the ease with which bacilli enter the lungs when infected food is taken.

Gerhardt, using diluted tuverculous sputum, found 800 bacilli inhaled caused infection in animals, while 10 to 20 millions were swallowed without any effect. Dreyer infected guinea-pigs through the lungs with 40 bacilli only. Kossell, Weber and Heusse infected calves with 1 mg. by inhalation, whilst 1 gramme by the alimentary canal caused only minimal lesions.

Weber and Titze, using calves, found $\frac{1}{100}$ m.g. may cause infection by inhalation, whilst at least 10 m.g. is necessary by feeding. Reichenbach was able to cause tuberculosis in goats with $\frac{1}{100}$ m.g. of bacilli inhaled, while 5 m.g. by the mouth gave minimal results. Findel experimenting with dogs found 0.14 m.g. was sufficient in infect by inhalation, while 63 m.g.s. had no effect when swallowed. Finally using guinea-pigs, he found that 63 bacilli inhaled constantly caused tuberculosis;

20/

20 were sufficient in some cases and even 5 in very young animals. The ingestion of 20,000 bacilli as food produced no effect. Eastwood gives 4,500 bacilli as the maximum non-infecting dose by ingestion.

Experimental evidence, therefore goes to prove that infection occurs more readily when the bacilli are inhaled than when ingested, and that, in the former case, a very much smaller dose of the virus is necessary. According to Cobbett, this may be due to the greater efficiency of the lymphoid tissue of the intestinal mucosa and mesenteric glands. Normally, this lymphoid tissue is exposed to vicarious attacks of both exo- and endogenic infections to a greater extent than any other of the regional lymphatic systems. The phenomenal powers of resistance to septic infection displayed by the peritoneum are well-recognized by surgical procedure, and Cobbett contends that the explanation, so far as tuberculosis infection is concerned, lies in the fact that intestinal lymphatics become more efficient the more work is given them - provided always the initial stress of infection does not suddenly overwhelm the resistance.

Be that as it may - further facts are at hand which clearly lessen the importance of the intestine as/

as a portal of entry of tuberculous infection. Kitasato states that, in Japan, where infants are suckled for two of three years and tuberculosis in unknown in cattle, children suffer from the disease with the same frequency as in other countries. In China similarly artificial feeding of infants in unknown, yet tuberculosis is rife. The logical inference is, that infants acquire infection from human sources, by inhalation, inasmuch as the intimacy between a suckling and its mother who happens to be an "open" case of phthisis, obviously conduces to this method of infection.

The question of bovine tuberculosis in children is closely related to the subject of infection by way of the alimentary tract. Reference has already been made to the proportions of tuberculous disease in children caused by the bovine organism. In the present state of our knowledge, it is impossible to deny that a certain amount of infection does take place through the intestinal mucosa. A strong plea has been raised for the supposition that, in the vast majority of cases, infection is acquired in this way. To offset that plea, Cobbett points out, that, as pulmonary infection can take place during the act of feeding, it is only reasonable to suppose that a certain proportion of bovine infection gains an entry in that way. Fifty per cent. of the cases of miliary tuberculosis and tabes mesenterica in children are stated

to/

to be due to the bovine organism: Cantley says that in three-quarters of all cases of these diseases the bronchial glands show evidence of primary infection and argues therefore that in three-eighths of the cases, bacilli must have entered by tracts other than alimentary. According to the Reports of St. Thomas' Hospital, tuberculosis of the peritoneum and mesenteric glands forms only a small proportion of the tuberculous affections of infancy and childhood; nine per cent. under the age of 5 and 7, and three per cent. under the age of 10. These examples are valuable proof of infection by milk, but, in addition, they shed an interesting sidelight on intestinal infection. Granting that primary implication of the mesenteric glands and peritoneum is proof of intestinal infection, how are we to account for the 50 per cent. of the cases with the bovine bacillus as originator, if it enters only through the intestine?

Protagonists of the theory of intestinal infection quote as corroborative evidence, the increased liability to tuberculosis of children belonging to the poorer classes, though probably more children of the wealthier classes in proportion are artificially-fed. The explanation usually given is that the milk supplied to poor people is often inferior, and contaminated, and given un-cooked. But unless it/

it can be shown definitely that bovine tuberculosis shows a greater ratio of incidence amongst the artificially fed infants of the poor than amongst those artificially fed of the rich - and that tuberculous peritonitis is more common among the poorer classes - this argument cannot be used in favour of an intestinal infection through milk. We are, therefore, forced to conclude that the increased opportunities for acquiring infection from human sources by way of inhalation, must be held accountable for the preponderance of tuberculosis amongst the children of the poor.

An extremely common portal of entry is the tonsil, which, from its position, is exposed to both air- and food-borne infection. Entrance of the bacilli is doubtless facilitated by the frequency with which the tonsils are the seat of hypertrophy and catarrhal inflammation. Wood found that 5.2 per cent. of enlarged tonsils contained virulent tubercle bacilli, chiefly of the bovine type. By using the animal-inoculation method, Dieulafoy and Latham, working independently, found 25 tuberculous tonsils in 105 experiments.

A very considerable proportion of cases of cervical adenitis is doubtless due to infection through the tonsil. At the same time, the importance of tonsillar infection in the causation of phthisis has been greatly overestimated of/

of recent years. There is no causal relation between the incidence of cervical adenitis and that of phthisis. Practically the same remarks are applicable to the gums as a portal of entry. The inflamed and irritated state of the gums during the teething of infants and in dental caries of later life, no doubt furnish a locus minoris resistentiae, which allows the bacilli to pass through and implicate the cervical glands. Milk-borne infection readily gains an entry through both of these portals, as high as 90% of cases of cervical gland tuberculosis having been found to be due to the bovine bacillus.

Certain broad principles emerge from the study of the portals of entry of tuberculous infection. The bacilli may gain entrance to the human organism in a variety of ways, which are classified on an anatomical basis. We must not, however, lose sight of the fact that infection depends upon factors which are biological rather than anatomical. Infection, no matter how presented, chooses the path in which its entry, from any reason whatsoever encounters the least resistance on the part of the tissues attacked. Local devitalization of mucous surfaces appears to be the decisive factor in determining the portal of entry. Generally speaking, tuberculous infection is acquired during early youth.

Hamburger/

Hamburger found that at the age of 14, 94% of the children of artisans in Vienna showed signs of infection with tuberculosis. Fishberg states that the children of poor but non-tuberculous parents in New York City gave positive reactions to the tuberculin test as follows: under one year of age, 10%; between 1 and 2 years, 33.33%, the proportion steadily increasing thereafter until the age of 14, when 75 per cent. were found infected. Newly-born infants, even of tuberculous parents are almost invariably free of infection. As age advances, however, the demands made on the internal economy of the body by active growth of the tissues, lower, in some way hitherto unrecognized, the natural powers of resistance to infection. The actual paths allowing of the entry of infection, therefore, become a secondary consideration, and primary importance must be attached to those factors personal or environmental which determine their selection. Reference will be made to these at a later stage.

Koch thought that, in children, tuberculosis of intestinal origin was rare. Von Behring held that all tuberculosis was contracted in infancy, the bacilli entering the body through the intestine. Calmette, on the strength of experimental work, maintains that the vast majority of cases of pulmonary tuberculosis are of intestinal origin. Sims Woodhead/

Woodhead produced evidence in support of the preponderance of intestinal infection in agreement with the opinion of Sidney Martin. Cobbett and Cautley, on the other hand, maintain that although tuberculosis is frequently of intestinal origin especially in children, inhalation is the common method of infection, not only in phthisis, but in other forms of tuberculosis especially those in which the bronchial glands seem to be the parts first affected.

This much is certain, that the bacilli, after ingestion or inhalation, pass through the mucous membrane of the Alimentary or Respiratory tracts, with or without a lesion visible under the microscope. They reach the lymphatic glands and thence if the disease progresses, the venous circulation, giving rise to a tuberculous bacteraemia. Once the infection occurs thus free in the general circulation, it may settle down in any tissue, the seat of election being determined by those factors which combine to create a locus minoris resistentiae. Calmette holds that a primary tuberculo-bacillaemia is a constant event in the production of all tubercular manifestations, including phthisis.

There appears to be little room for doubt but that a tuberculo-bacillaemia is a necessary antecedent to a certain class of non-pulmonary lesions, especially in children, and/

and it is by no means difficult to understand with Calmette, that the same is true of all tuberculous lesions, whether in bone, gland, or lung. Acute miliary (generalized) tuberculosis is obviously the outcome of an infection which has gained access to the general circulation in a manner analogous to the septicaemias of the pyogenic diseases. At the same time, there are several alternative theories of the origin of lung-involvement in tuberculosis, which claim respectful attention.

Infection residing in a gland at the root of a lung may spread by ulceration into the lumen of a bronchus and set up a tuberculous broncho-pneumonia (Aerogenic Theory); or (2) into a vein leading to a local circulatory infection. Aufrecht holds that the most frequent source of lung infection occurs as the result of a lesion forming in the wall of a pulmonary blood-vessel in contact with a breaking-down tuberculous gland. Ribbert, Bacmeister and Aufrecht strongly advocate the haematogenous origin of phthisis.

As opposed to this, there is the theory of direct, lymphogenic origin of pulmonary lesions, as in the case of phthisis following a tuberculous peritonitis, or more commonly, the passage of inhaled bacilli through the tracheo-bronchial glands direct to lymph-nodes in the lung matrix.

Conceding/

Conceding that, in all likelihood, pulmonary lesions may arise in accordance with each and all of these theories, we must not lose sight of the fact, that from the broad standpoint of preventive medecine, the question of supreme importance in this connection is: How comes it, that of all those who have acquired tuberculous infection in one form or another - and that number includes the mass of adult humanity - only a small percentage suffer from phthisis?

FACTORS PREDISPOSING TO TUBERCULOSIS & ETIOLOGY.

The development of phthisis is a phenomenon peculiar to tuberculosis in the human species. The pathological entity of phthisis does not occur in the lower animals - in them, implication of the lungs occurs as part of a generalized tuberculosis, and is neither anatomically nor clinically comparable to phthisis in man.

Apart from the influence of age and sex, phthisis is definitely related to certain personal and social factors, which separately or in conjunction, predispose the organism to its development. From the point of view of prophylaxis, we are chiefly concerned with those factors, which are susceptible of removal or mitigation. At the same time, it is necessary to refer to the indeterminate influences of heredity and immunity, so far as these are related to phthisiogenesis.

By reason, doubtless, of its plausibility, the theory of hereditary predisposition to, or transmission of, phthisis, has long obsessed the minds of the laity. To the superficial observer, the recurrence of consumption in successive generations/

tions of a family, might well have suggested prima facie evidence of an inborn taint, which "bred in the bone will appear in the flesh."

Subjected to the criticism of known facts, however, the theory of hereditary predisposition becomes untenable. The mere fact of the recurrence of phthisis in successive generations, or in several members of a family, is no proof whatsoever. Having in mind the enormous tuberculization of modern civilized communities, what can be more reasonable to expect than that phthisis, accounting, as it does, for 8 per cent. of the total death rate from all causes, would normally occur in any large family or its branches? The odds at the present time are one in twelve that phthisis will so occur as a cause of death, and one in four or five as a clinically recognizable disease.

Statistics are of no help in furnishing data. It is well-nigh impossible to obtain accurate details of the cause of death in antecedents, even from people of an intelligent class. In those cases where the frequent occurrence of consumption in a family is definitely ascertainable, it is equally impossible to rule out other factors which could account for the apparent effects of heredity. From my own experience I find it impossible to dissociate the perpetuation of a predisposing environment - a social hereditary - from the evils/

evils popularly ascribed to a diathesis or biological heredity. For example, take the case of family predisposition, so called, among villagers of the Western Isles. In Lewis and Harris, there are villages of one thousand inhabitants and upwards, the houses of which are largely of the primitive "clachan" type - low, rush-thatched, two-roomed dwellings, which have been occupied by the same family for many generations. Damp, ill-lighted, ill-ventilated and often grossly overcrowded, these houses are handed down from father to son as a precious heirloom, and saved from dereliction by that extraordinary sentimental attachment which the Islander holds for the ancient dwelling of his fathers. From the day that the Tubercle Bacillus first gains entrance to a social milieu of that description, one thing is certain, that the environment which is most favourable to its activity and retention or virulence, will continue to operate through successive generations.

Under these circumstances, "family" heredity may be more truly interpreted as social heredity.

What are the facts relating to the question of true, biological heredity? Harlow Brooks has shown that the progeny of tuberculous cows show no excessive predisposition to the disease. The Bang system of cattle-selection in Denmark depends upon the fact that breeding from tuberculin-reacting cows/

cows is the best method of securing a tubercle-resisting stock. From this we may infer that the serum of animals infected to a harmless degree, develops a tubercle-resisting power which is passed on to successive generations. We are therefore justified in assuming, that whatever biological influence is inherited, it is more likely to be one which, so far from encouraging, actually militates against the re-appearance of the disease in subsequent generations.

The view has been advanced by Brehmer and others that some organs or tissues of the body lack powers of resistance to tuberculous infection. That some such locus minoris resistentiae may be transmitted by heredity is disclosed by the fact that when phthisis appears in patients and children, the chances are great that the same side of the chest should be affected in each case. Moeller points out that when a child suffers from tuberculosis of a bone, the chances are when its brother develops tuberculosis that the disease will occur in bone and not in the soft tissues. It has also been observed that phthisis often attacks parents and children at the same age.

These apparent anomalies of tissue-reaction are of relatively little importance in the question of an hereditary diathesis. Coincidence of extraneous influences can in no case be ruled out, and in the present state of our knowledge, these/

these observations fall far short of proving the existence of a true biological heredity. Further reference to the subject will be made later, when the subject of Immunity is discussed.

Freund and Bacmeister are responsible for the opinion that certain structural peculiarities of the thorax predispose to the onset of pulmonary disease. In a series of autopsies performed on victims of phthisis, Freund discovered that, in a considerable proportion of cases, stenosis of the upper thoracic aperture was present. He argued therefrom that there existed a causal relation between the presence of thoracic deformity and the occurrence of pulmonary lesions in tuberculosis. The stenosis, he supposed, was due to premature ossification of the first rib with consequent shortening, resulting in encroachment upon the space normally available for the lung apex. Pressure upon the lung apex resulted in interference with the circulation, the lymph-flow and passage of air through the apical bronchioles. Stasis so produced in the apex had the double effect of favouring the deposition of micro-organisms and diminishing the efficiency of the local protective forces, creating, in fine, a locus minoris resistentiae.

Bacmeister produced thoracic stenosis experimentally in rabbits, and found that on being infected with tubercle bacilli/

bacilli, these animals developed localized pulmonary lesions while normal animals developed the customary generalized form of tuberculosis.

Clinically, corroborative evidence is at hand. Apical phthisis practically does not occur in children, in whom the cartilaginous nature of the upper ribs afford free play to the subjacent lung. In early adult life, however, the growing lung may be pressed upon as a result of narrowing of the upper thoracic ring - and this is the age at which phthisis most frequently occurs.

Keith points out that stenosis of the upper thoracic aperture may be a result, not the cause of phthisis in the lung apex, and further, several authors have failed to find that thoracic stenosis occurs as frequently as claimed by Freund.

The importance of anatomical peculiarities as factors in phthisiogenesis is therefore, still an open question. A similar concession must be made in the case of abnormalities in secretion of the Ductless Glands. The study of the influence of the endocrime organs upon the resistance of the organism to disease, is still in its infancy.

Among those diseases which are held to act as predisposing to the development of phthisis, chief place must be given to affections of the respiratory tract and the acute infectious/

infectious diseases, measles, whooping-cough and influenza.

The importance of a pre-existing catarrh of the upper respiratory passages as the first step in preparation of the soil for the reception of tuberculous infection, has been insisted upon by many observers. Not a few are inclined to believe that catarrhal conditions of the respiratory tract, e.g. Rhinitis, Bronchitis, etc., by throwing a constant strain upon the protective agencies - lymph-glands, phagocytes, etc., - impair the functions of these agencies to a degree which permits of the onset of pulmonary tuberculosis. Measles and whooping-cough, by reason of the severe respiratory irritation which accompany the malady and the frequency with which a lingering broncho-pneumonia occurs as a sequel, are held to be especially culpable. Apart from the fact that local devitalization of the respiratory system takes place, the general constitution is weakened as a result of the febrile disturbance, favouring the reactivation of a dormant lesion or accentuating the potency of a fresh infection. Again, the severe cough of acute bronchitis or whooping-cough may rupture tuberculous glands in the chest - in any case, tuberculous broncho-pneumonia is frequently seen to follow an attack of measles or whooping-cough in children.

Pure lobar pneumonia has little relation etiologically

to/

to phthisis. Pleurisy, often cited as a pre-existent affection, is, in the majority of cases in which phthisis supervenes later, really tubercular from the start and considered as such, cannot be held to be a predisposing cause.

Of considerable interest is the relation of Pulmonary Emphysema and spasmodic asthma to phthisis. It appears that to some extent, the diseases are mutually exclusive. Why this should be so, is not clear. In emphysema, the atrophic condition of the lung parenchyma is supposed to be unfavourable to the growth of tubercle bacilli. The passive venous congestion of the lung which occurs in emphysema, mitral stenosis and aortic disease is also held to be detrimental to tuberculosis of the lung.

Epidemic influenza is not, strictly speaking, responsible for the causation of phthisis ab initio. Very few cases of consumption can at the present moment be attributed to the effect of an attack of influenza during the terrible pandemic of three years ago. The effect of an influenzal attack is in the majority of cases confined to the lighting-up of a pre-existing tuberculous lesion in the lung. Influenza during 1918-19 doubtless accounted for a number of deaths which would normally have accrued to phthisis./

phthisis. But these deaths were due to influenzal pneumonia, not to concurrent phthisis. My own experience in treating influenza complicated by chronic phthisis during the autumn of 1918 was in accordance with these facts. I was frequently astonished at the recovery of phthisical patients who suffered a relapse of pulmonary disease following an acute attack of influenza. Treated on open-air lines and well-stimulated, such cases, by making a fine recovery, surprised their relatives, who, knowing their already delicate state of health, looked for a speedy and fatal termination of the illness.

Occupation has always been given a prominent place as a factor predisposing to phthisis. Certain occupations which show a high percentage of phthisis mortality may not however be, per se, the essential cause. In obedience to the laws of economics, weakly persons are attracted to certain occupations, such as gardening, hotel-service, etc., which show a high phthisis mortality. Healthy workers under the same working conditions do not show excessive liability to phthisis.

The relation of phthisis-incidence to industrial conditions, itself a vast topic, turns upon the extent to which the stress of occupation depreciates the vital disease-resisting powers of the organism - either constitutionally or/

or locally. In the former category, excessive fat. and exposure to extremes of temperature, in the latt. the inhalation of irritating dust-particles, form the main factors to be considered.

Excessive fatigue is, of course, not peculiar to the etiology of phthisis. There are few constitutional maladies which do not stipulate its influence as a predisposing factor - at the same time it is fitting to emphasize the importance of the part played by excessive fatigue in the prevalence of phthisis amongst factory workers in the days before modern factory legislation reduced the working hours of operatives to a limit consistent with the maintenance of health.

The influence of extremes of temperature is well seen in the case of ship-stokers and firemen, who show an increased liability to consumption as compared with the men before the mast.

The most striking example of the occupational factor in the causation of phthisis, however, is to be found in the case of those occupations which involve the inhalation of irritating particles of dust into the lungs.

The ease with which dust can be inhaled into the lungs and become deposited in the lymph-glands draining the respiratory mucous membrane is well seen in the pneumokonioses/

ioses. Lesions are produced which vary in intensity according to the nature of the dust inhaled. Non-irritating dust such as that of coal and limestone gives rise to a species of emphysema, due to dilatation of air-vesicles between patches of lung consolidated from the deposition of inhaled dust. This emphysematous condition is known as "Coal-miner's Phthisis," but is not true phthisis, neither does it predispose to the subsequent development of true tuberculosis of the lungs.

Very different results, however, follow the inhalation of dust-particles such as those of silica, steel, sandstone, tin, lead, etc., which are markedly irritant to the respiratory mucosa. The respiratory diseases resulting from these causes appear to predispose strongly to the development of phthisis.

In 1908-1909, in the United States, phthisis caused 31 per cent. of total mortality among working males from 25 to 34 years of age; among grinders, 71 per cent.; among tool-makers 59 per cent.; stone-cutters and weavers 55 per cent. and among woollen-workers 44 per cent. That no part of this excessive mortality could be ascribed to indoor working conditions per se is proved by the fact that among boot and shoe makers and millers, also indoor workers, the phthisis mortality rates were the least of any/

any.

It appears that liability to dust-borne phthisis is incurred only in those occupations which involve the inhalation of irritant mineral dust and metallic dust. The type of phthisis produced is of a special form - slowly progressive, possessing a low infectivity and atypical symptomatology.

Malnutrition undoubtedly constitutes a potent factor in the causation of phthisis. The effect of war-time privation has been signalized, in many European communities, by a distinct, and in the case of some of the belligerent nations, alarming, rise in the phthisis mortality rate. In Vienna, which was very hard hit economically, following the break-up of the Hapsburg Empire, the rise in tuberculosis death-rates was appalling. Dr. Chalmers, Medical Officer of Health for Glasgow, attributes the marked rise in the phthisis death-rate for Glasgow during the present year to the poverty among the working classes resulting from the depression in the engineering and ship-building trades on the Clyde.

Perhaps of all the factors concerned in the etiology of pulmonary tuberculosis, pride of place may be given to deficient housing conditions. Overcrowding and all that it entails, insufficient air-space, bad ventilation and lack/

lack of cleanliness constitute a syndrome of social evils which more than any other perpetuate the scourge of consumption. It is unnecessary to quote statistics to show that the incidence of phthisis bears a direct ratio to the amount of overcrowding in any community, urban or rural. It is now recognized on all hands that the most salutary prophylactic measures are those which aim at the reduction of slum conditions and attendant evils. Granted that all the problems of tuberculosis cannot be solved by the provision of adequate housing accommodation, it must be frankly acknowledged that, as a basis of preventive effort, such provision amounts to a sine qua non.

Viewed as to its etiological significance, the effect of unhygienic home conditions falls to be considered under two heads, according to whether that effect depends upon (a) the increased opportunities for infection and "mass" infection and (b) the depreciation of vital resistance.

Experiments conducted on animals have shown that the amount of dosage of infection is closely related to the type of disease produced, i.e. the larger the dose, the more severe the reaction. No such experiments can, of course, be conducted in the case of human beings, but clinical observation supplies relative information. In young children tuberculosis when it causes disease appears as/

as a general disease, like typhoid or septicaemia; as a metastatic infection, i.e. generalized miliary tuberculosis; or as an acute broncho-pneumonic process, rapidly fatal in the majority of cases. Now very many cases of tuberculous infection in children never proceed beyond a local lesion in gland or bone, in still more the disease does not demonstrate itself clinically. How is this discrepancy to be explained?

The explanation is that the acutely fatal forms of tuberculosis infection in children are due to a primary "massive" infection of an organism that has hitherto been free from the tuberculosis virus - real virgin soil.

One cannot fail to associate the opportunities for "mass" infection with those unhygienic conditions which accompany overcrowding. Time and again one has met with households in which a consumptive in the last stages of the disease shared the same sleeping apartment with four or five children or young adults. "Massive" infection of the hitherto uninfected organism is not the only possibility. "Massive" superinfection of a previously infected and hitherto partially immune subject may as readily be followed by the onset of a severe type of phthisis.

Depreciation of vital resistance undoubtedly predisposes to the severity of the end-results of infection, whether/

whether exo-or endogenic. A dose of tuberculous infection, which would have little or no effect upon a healthy organism existing under ideal conditions, would be capable of producing a grave type of disease in the same class of subject living in a vitiated environment. Innumerable experiments have proved the paramount importance of hygienic surroundings in the maintenance of vital resistance against disease. One example will suffice. Trudeau inoculated a number of rabbits with equal doses of tubercle bacilli; half were allowed to run free in the open air and the remainder were placed in a damp hole to which sunlight had no access. Both sets of rabbits were killed at the same time, and it was found that the first had recovered or had only slight lesions, while the second had extensive tuberculosis.

Tubercle bacilli may retain life and virulence over a protracted period in dwellings to which access of sunlight and fresh air is denied. Thus, the conditions found in overcrowded dwellings form a vicious circle of which the components are increased opportunities of infection, retention of virulence of the virus and depreciation of vital resistance to disease on the part of the inmates.

We have discussed in the foregoing the main factors, personal, social and economic which conduce to the production of phthisis in the mass, but none of the facts so far detailed either/

either separately or in combination, furnish an explanation of how phthisis develops in one individual and not in another, when the same extraneous factors operate in both.

The selective preference of phthisis, if one may so generalize it, points to the conclusion that the ultimate deciding factor in phthisiogenesis resides in the vital economy of the individual, as a biological peculiarity. Efforts have been made to identify this peculiarity with a hereditary diathesis. Such a conclusion we have already noted as being founded on fallacy. Others, again, have inferred an increased susceptibility or lessened resistance of a specific nature.

To postulate increased sensibility as essential to the origin of phthisis practically amounts to an evasion of the main issue. An hypothesis of this kind rests upon an empirical basis, inasmuch as abundant proof exists that, to the general rule that initial sublethal infection in bacterial disease is followed by an acquired immunity either temporary or permanent - tuberculosis is no exception.

Facts are now available which offer a solution to the riddle of phthisiogenesis on the basis of the phenomenon of acquired Immunity. Briefly stated, it is held that immunity to subsequent infection is acquired in infancy as the result of a sublethal dose of tuberculous infection. This/

This immunity retains its potency until adult life, when, should it for any reason fail, the immune individual develops phthisis. Should it however retain its protective power throughout the life of the individual, phthisis does not occur. Let us examine the evidence in support of this views

The study of immune phenomena has revolutionized the pathology of germ-borne disease. By immunity is meant "non-susceptibility to a given disease or to a given organism, either under natural conditions or under conditions experimentally produced." (Muir and Ritchie).

Natural Immunity is found in the case of those native tribes inhabiting tropical regions, who are not susceptible to attack by the malaria parasite. Many of the lower animals are naturally immune to diseases affecting man and vice versa. Immunity may be acquired as the result of an attack of any given disease. For example, one attack of measles, whooping cough, or scarlet fever confers a lasting immunity upon the individual against a second attack. Experimentally, immunity can be produced in laboratory animals by the method of inoculation. The injection of sublethal doses of virus at suitable intervals leads to the establishment of an artificial or acquired immunity, the degree of which depends upon the virulence of the organisms used. Varying degrees of immunity can be produced - in general, it may be taken that the higher the/

the virulence of the infecting organism, the higher will be the degree of immunity.

In the case of erisypelas, influenza and pneumonia, the immunity conferred by an attack of the disease is very short, and the end-result may be that the individual is more susceptible to attack than before. It has been proved experimentally that immunity is dependent upon several extraneous factors. Depreciation of vitality, from any cause whatsoever, tends to remove the protection afforded by immunity.

It is generally held that the blood-serum is the chief agency concerned in the production of immunity. Metchnikoff believed that immune phenomena depended upon a special function of the leucocytes and local tissue-cells (phagocytes). It is probable, however, that phagocytosis is the effect rather than the cause of immunity.

Acquired immunity, is, therefore a specific physiological reaction of the tissues to microbial invasion. The net result of that reaction is to confer a variable degree of non-susceptibility to recurrence of the disease inducing the reaction. What part, then, does Immunity play in the causation of phthisis?

To begin with, it has been shown that from 70 to 90 per cent. of children under the age of 16 react positively to/

to the tuberculin test - that is to say, the great majority of the infant and juvenile population have acquired tuberculous infection in one form or another. A certain proportion develop tubercular lesions in gland, bone or elsewhere, a small proportion die of acute miliary tuberculosis or tubercular meningitis - but the vast majority of children suffer no apparent inconvenience as a result of infection. This latter class, together with those who survive tubercular lesions acquire a measure of immunity towards tuberculous infection - and disease - in future. The subsequent history of each case depends, inter alia, upon the interaction of the opportunities for re-infection and the protective forces of immunity. If the immunity acquired in youth is sufficient to tide the possessor over the exigencies of adult life, then phthisis will not develop. If, on the other hand, the immune forces fail to cope with the stress of re-infection or superinfection, then phthisis will result.

The question immediately presents itself: Why, in such cases, should phthisis develop, and not miliary tuberculosis or tuberculous meningitis?

Acute miliary tuberculosis and meningitis are, characteristically terminal events in the graver cases of tuberculous infection in childhood. Pulmonary tuberculosis alone/

alone, occurs with extreme rarity as a cause of death in children. Similarly, adults of native races coming into contact with tuberculous infection for the first time, succumb to acute miliary tuberculosis and meningitis rather than to phthisis. When the seed, so to speak, is planted in virgin soil, where no measure of immunity exists, the distribution of the lesions is similar to that in pyaemia and the character of the disease equally acute.

Mark the contrast when an adult of civilized race receives an efficient dose of tuberculous infection. Instead of an acute miliary tuberculosis or meningitis, he develops phthisis - because of the measure of immunity he has acquired from a previous infection in childhood.

Failure of immunity at the crucial moment, therefore, determines the onset of phthisis, be the cause of that failure what it may. It may be that the seed of future mischief is planted in youth when tuberculous infection has been met for the first time and for the time being, held in check. It may be that "massive" infection in youth, the susceptible age, has been barely recovered from and the organism is left to face the future with no safe margin of immunity. It may be that all those influences, personal, social and economic, which we have noted as being inimical to health, combine to weaken the forces of resistance to secondary infection/

infection. This much, however, is certain, that even when immunity does fail, it is still sufficient in the great majority of cases, to prevent the onset of acute miliary tuberculosis and to limit the disease to a slowly progressive lesion in that most susceptible and least resistant organ - the lung.

This interesting theory offers a reasonable explanation of the variations in clinical type, so characteristically found in phthisis and so mysterious in origin. So far no satisfactory reason has been advanced for the fact that phthisis pursues, in one case, a swift, unremitting course to a fatal termination, in another, a snail-like crawl to partial cure or arrest of the process. May not the variations in clinical type find a parallel in the fluctuations of individual immunity or resistance?

How otherwise are they to be explained?

GENERAL PRINCIPLES OF TREATMENT AND PREVENTION.

There is no specific therapy for Tuberculosis. Attempts to produce a specific remedy based upon serological reactions have so far proved barren. Drug therapy has proved of singularly little avail in the treatment of any form of the disease.

The treatment of pulmonary tuberculosis a few generations ago, must have been a dilemma for the physicians of that time. Hide-bound to a doctrine of treatment dating back to Hippocrates, the best that physicians could do was to place the phthisical patient in close confinement in a stuffy, overheated room, thereby removing the last vestige of chance the patient might have had of recovery. The prognosis of phthisis under such conditions of treatment was, naturally, hopeless.

George Bodington, an English village doctor, was the first to demonstrate the value of the open-air method of treatment for phthisis. In 1840, Bodington published his "Essay on the Treatment and Cure of Pulmonary Tuberculosis," in which he condemned the existing methods and boldly advocated the virtue of fresh air and the generous administration/

tion of nutritious food. Like many apostles of a new creed, Bodington was severely handled by his contemporaries, both lay and professional. Nineteen years later Brehmer in Germany and Trudeau in America followed up the work of Bodington, but it required the stimulus of Koch's discovery of the Tubercle Bacillus in 1882, to effect the general adoption of institutional treatment for phthisis.

Numerous sanatoria were subsequently set up at considerable cost, in England, Germany and America, and success achieved in the treatment of early cases of phthisis gave rise to high hopes of substantially reducing the mortality and mass incidence of the disease.

Time has established the sterling value of the sanatorium as a curative agency but its sphere of usefulness has been found, by experience, to be definitely limited. The early claim made for institutional treatment, that it would prove, in effect, a potent factor in general prophylaxis, has, however, not been justified.

To-day we are able to cast a retrospective eye on the record of nearly half a century's trial of institutional treatment. We mark in the spectacle of a death-rate not materially affected by its influence the passing of exaggerated hopes of its prophylactic value. We appraise the gradual emergence of a right and proper understanding of the true role/

role of the sanatorium. As a curative and educative agency institutional treatment takes its place legitimately as a unit in the comprehensive system of general prophylaxis.

The principle cannot be too strongly insisted upon that c curative treatment of the individual case is but one desideratum among many in the large problem of prevention. The anti-tuberculosis campaign of the future must adopt for its line of action the principle of Prophylaxis for the mass, instead of as in the past, limiting itself to cure of the individual "open" case. Preventive Medecine cannot afford to individualize. Perhaps the gravest indictment that can be levelled against the anti-tuberculosis campaign of past years is the abnegation of this vital principle.

Hitherto, preventive measures have been largely based upon the belief that elimination of the factor of infection at its source, is likely to produce the best results, and further, that institutional treatment and segregation have been, to a considerable extent, responsible for the decline in phthisis-mortality.

With regard to the first, the fact that something like ninety per cent. of adults are already tuberculized, points to the absolute futility of attempting to eradicate the B. Tuberculosis from civilized communities. With regard to the second contention, experience has proved it to be fallacious/

fallacious. Koch and Cornet stated at the anti-tuberculosis Congress in London that while there were at least 226,000 persons disseminating tubercle bacilli in Germany, only 20,000 persons were cared for in institutions, and of these latter only 4,000 expectorated bacilli. The influence of institutional segregation acting upon so small a proportion of the total existing disease could scarcely have a perceptible effect upon the morbidity or mortality from tuberculosis.

Exposure of errors in the past leads to a consideration of the positive facts that are now available to us for guidance in formulating a system of prevention. Our present knowledge of the etiology and epidemiology of tuberculosis makes it abundantly clear that the problem is a social rather than a medical one.

Setting aside, for the moment, all subsidiary considerations, let us press for the definition of what shall constitute a true test of a successful system of prophylaxis.

It is that system, surely which in virtue of its exercise, shall ensure that the susceptible individual will remain free from the disease. For this to occur, we have seen that it is necessary for the specific resistance of the individual to be maintained at par. Prophylaxis therefore, is efficient in so far as it augments or maintains the specific/

specific resistance of the individual.

In our search, therefore, for a guiding principle on which to develop a rational scheme of prevention, we are confronted with a plain issue. The goal of all our efforts to eradicate tuberculosis lies in the maintenance of specific resistance not only in the individual - but in the aggregate of individuals - the community at large.

The enormity of the task which lies in front of preventive effort can be dimly realized by bringing into review those factors, personal, social and economic, which we have noted as bearing inimically upon the general health of the community. Maintenance of general health postulates a high state of resistance to microbial disease in general - and in particular, to the development of tuberculosis.

Viewed in this light, prophylaxis against tuberculosis embraces in its scope all those many and divers influences which are at work in ameliorating the living status of the poorer classes of the community, among which phthisis is particularly rife. Slum conditions are notorious for the causal relation they bear towards phthisis. Poverty, malnutrition, overcrowding, low resistance to disease generally are concomitants of slum existence which unfortunately cannot be eliminated by the provision of better housing conditions alone. It is by no means uncommon to find/

find the occupants of a good house - so far as space and ventilation are concerned, creating for themselves the vitiated milieu of the slum through sheer ignorance of the way to live.

Elimination of slum elements would certainly go far towards the solution of social problems of the present day, that of tuberculosis included. But what is scarcely less essential at the moment, is the education of the community - especially those sections of it peculiarly liable to tuberculous disease - in the fundamentals of domestic and personal hygiene.

The history of the modern campaign against tuberculosis falls, broadly speaking, into two phases. The first represents the attempt to reduce the evil by intensive institutional treatment of extant cases, and removal of the gross source of infection to others by segregation of chronic infectious cases in special hospitals. The present policy, while not neglecting either measure, concentrates upon the endeavour to place the phthisical in the best position to cure himself, and to maintain the resistance of susceptible individuals at an efficient level.

Though certain elements of the problem of prevention, such as poverty and overcrowding, occur as more or less constant features, it will be found in practice that conditions affecting/

affecting the spread and development of phthisis vary widely in different communities. In scattered rural or insular areas for example, as compared with large urban communities, not only may the elements of the problem differ widely, but in addition, the line of action to be adopted in prophylaxis may be totally different.

Anti-tuberculosis measures first took shape in those communities in which the necessity for active intervention first presented itself, to wit, the large cities. The City of Edinburgh may justly claim to have led the world in the adoption of a rational system of treatment and prophylaxis against tuberculosis. Known as the Dispensary System, the scheme was instituted by Sir Robert Philip, 34 years ago. Combining as it did the functions of a centre for early diagnosis, a clearing-station for cases selected for treatment and a bureau of supervision, information and assistance in respect of the home life of domiciliary patients and contacts, the Dispensary formed an executive unit of the greatest possible utility, in the campaign against tuberculosis.

When it was first instituted the functions of the Tuberculosis Dispensary were to afford outdoor treatment and advice to patients and to a lesser degree, the establishment of contact with the existing mass of the disease. Later, its activities/

activities were extended to systematic inspection of the home-conditions of the patients and routine examination of contacts with a view towards making a diagnosis at as early a stage as possible. Close co-operation was subsequently effected with a variety of institutions adapted to the needs of varying phases of the disease - the Sanatorium for the treatment of early cases, the Hospital for advanced cases, the Farm Colony for occupational and vocational treatment, the Open-air School, the After-care Committee and so on. In this way the Tuberculosis Dispensary built up the framework of a complete unit of organization and administration of the different agencies engaged in the treatment and prevention of tuberculosis.

By recommendation of the Departmental Committee, the Dispensary System was adopted in due course, as a basis for co-ordination of anti-tuberculosis measures all over the country. Schemes adapted to the special needs of each area, were put in force by Local Authorities generally. The duties of administration were merged into County or Borough Public Health Departments, but the Dispensary, as an executive unit, continues to function in most Tuberculosis Schemes.

The stress of war-time, post-war trade depression, unemployment and poverty, have had the effect of definitely increasing the death-rate from tuberculosis. This fact alone must/

must stimulate unremitting effort to increase the scope and efficiency of practical preventive measures. Stringency of national finance inhibits any increase of establishment in the near future - it behoves us, therefore, to make the best of existing facilities. There is abundant evidence that, in many of the less progressive communities, much time, money and energy is being wasted through lack of proper appreciation of facts and possibilities.

Notwithstanding the lack of outside support, much can be done by Local Authorities in speeding-up the efficiency of their tuberculosis schemes. The time has come for ruthless scrapping of uneconomical methods and for their substitution by a reformed procedure, appropriate to the needs of the situation. To such end, a wide field of activity opens out to those responsible for the prosecution of prophylaxis against tuberculosis.

Features of the Tuberculosis Problem in the Western Highlands and Islands.

Fifty-two years ago, Dr. McNab, a physician practising in the island of Mull; wrote a scholarly article descriptive of the immunity from Consumption enjoyed by the inhabitants of the Hebrides. Some time previously the same subject had been treated by Dr. Morgan, who endeavoured to explain the phenomenon as due to a "special protective action" of peat-smoke. McNab sought to supplant this theory by another equally ingenious. He believed the benign influence to be the excessive amount of oxygen liberated into the atmosphere by the marine algae which grow so luxuriantly on the rocky shores of the sea-girt Hebrides.

Needless to say, neither hypothesis as to the non-prevalence of consumption can be seriously entertained - but the articles are of great interest and importance inasmuch as they afford incontrovertible proof of the remarkable absence of tuberculosis among the inhabitants of the islands and West coast of Scotland at that period.

The position in regard to the incidence of tuberculosis in that area to-day is the antithesis of what it appears to have been some fifty or sixty years ago. Tuberculosis is now excessively prevalent in the Western Highlands and the/

the Hebrides as compared with the average county district in Scotland.

Comparative analysis of the statistical returns prepared by the Registrar-General for Scotland, affords startling evidence of the toll levied by phthisis among the inhabitants of West Highland and Island districts. In 1919 the Phthisis-Death-Rate for the average Scottish county district (Highlands and Isles included) was .72 per 1000. In the same year, the phthisis death-rate for the Island of Harris was four times greater than the rate for the average Scottish County district - whilst the rate for Lewis was three times, for North and South Uist, Lorne, and South-Western district of Ross, twice - as great.

With the exception of the small burgh of Kingussie in Inverness-shire (4.01 per 1000) and the County District of Walls in Orkney (3.60 per 1000), the Phthisis-death-rate for the Island of Harris (3.22 per 1000) was the highest of any burgh or county district in Scotland in 1919.

In the remainder of the 20 Western or Insular local government districts of Argyll, Inverness, Ross and Cromarty, and Sutherland, the phthisis-death-rate was, with one exception, constantly greater than that of the county districts of Scotland as a whole.

Allowing/

Allowing for the fallacies naturally incident to the statistical comparison of small populations, it is nevertheless wholly apparent that tuberculosis, more especially the pulmonary form, is unduly rampant in the Western Highlands and Isles. It is somewhat remarkable that the lapse of some fifty or sixty years should suffice to alter, so completely, the status of a community in regard to the prevalence of tuberculosis.

The endemiology of Tuberculosis in the Western Highlands and Isles possesses many unique features. To begin with, during the period that the death-rate from tuberculosis in Scotland as a whole was steadily declining, the same death-rate in the Western Highlands and Isles was on the increase. It is common knowledge that the balance of health in a community is liable to be suddenly upset by a variety of causes, such as, for example, the rapid influx of foreign population consequent upon the setting-up of some new industry, the outbreak of famine resulting from failure of the ordinary means of livelihood and so on. Such instances are frequent in the early history of many recently established industrial centres. But in the rural area under consideration no such social or economic factor suggests itself as the de facto source of the anomaly in regard/

regard to the prevalence of tuberculosis. The inhabitants of the Western Highlands and Isles are reputedly conservatice in customs and mode of living. No industry on a scale capable of exerting an adverse influence on public health, has been introduced into the Highlands during the past fifty years. The population of Highland and Island districts has not increased during that time - in point of fact, the tendency, in the main, has been towards substantial decrease. This fact is important in another connection inasmuch as it detracts from the possible effects of the notoriously bad and insufficient housing conditions which obtain in remote Highland districts. Granting that such conditions in the average community clearly favour the prevalence of the disease, is it quite reasonable to suppose that, ceteris paribus, their mere persistence for a further half-century, would alone account for a remarkable increase in the prevalence of Tuberculosis?

Truly, the problem presents features of novelty and to accomplish its elucidation we are constrained to look for an exciting cause, or causes, beyond those met with where the average community is concerned.

In order to appreciate more fully the exceptional features of the Tuberculosis problem in the Western Highlands and Isles, it will be found necessary to allude briefly to the/

the physical features, climate and meteorology of the area, before proceeding to analyse the social and economic factors relevant to the subject in hand.

The area under consideration comprises the Counties of Argyll, Inverness, Ross and Cromarty and Sutherland along with the group of islands, Outer and Inner Hebrides, which belong to the three first named shires. The population of the rural districts of this area - with the exception of Lewis and Harris - has been declining for many years, more especially since 1831. The small burghs, however, have been increasing steadily in size during the last fifty years.

The physical features of the mainland portions of each of the four Counties are, in the main, similar.

The coast-line is deeply indented by numerous sea-lochs running far into the land. The interior is a great stretch of mountainous country intersected by valleys of varying width. In the southern half of Argyllshire the hills are of medium altitude, grass-covered, and the valleys are comparatively open and fertile. North of Lochs Etive and Awe, the character of the surface changes abruptly. Successive ranges of towering mountains occupy the surface of the country until the north coast of Sutherland is reached. In the greater part of this tract the mountains are/

are separated by narrow glens, in the lower levels of which are numerous fresh-water lochs.

In Sutherlandshire and central portions of Ross-shire, the valleys between the hills widen out into "straths" containing alluvial soil deposited by the fime rivers winding through them.

The physical configuration of the Islands vary considerably. Of the Outer group, Lewis and the two Uists are comparatively flat, whilst Harris and Barra are extremely rugged. Of the Inner Hebrides, Skye, Rum, Mull and Jura partake of the characters of the adjacent mainland, but Tiree, Islay and Colonsay are of more uniform surface, flat and comparatively fertile.

The climate of the West Coast is mild and equable, but extremely wet. The mean annual range of temperature is small. Snow does not remain long on the fringe of coastline owing to the tempering effect of the sea. The climate becomes more severe as the western slope of the great watershed of the Grampians and Northern Highlands is ascended.

The fact that the area with which we are concerned lies roughly to the west of the great watershed of Scotland, is full of significance. The prevailing winds are south-westerly and, surcharged with vapour from the Atlantic, deposit/

deposit their moisture chiefly upon the western slopes of the watershed. Glencroe at the head of Loch Long in Cowal, holds the record for highest annual rainfall in Scotland (128 ins.). In general, the climate of the Western Highlands is excessively wet and this fact, doubtless, is partly accountable for the high percentage of respiratory affections among the inhabitants.

The climate and meteorology of the Islands are in the main similar to that described for the Mainland area. The rainfall is slightly less, the winter temperature more equable, but on the other hand, the Islands are more exposed to the force of gales which occur with great frequency in wintertime.

The inhabitants of the Western Highlands and Isles are peculiarly interesting in respect of their ethnology, history, manner of living and personal characteristics. They are a mixed race, derived from three main stocks, the Nordic, and the two branches of Celtic origin, the Older or Iberian Picts and the Scottish Celts who returned from Ireland about the time of St. Columba (circa 550 A.D.). While the three racial elements have largely combined to produce the present stock, it is quite possible to identify the original types even at the present day. The Norse element is particularly predominant in Lewis, while it exists to

a/

a lesser extent in the Uists, the majority of the Inner Hebrides and the fringe of the Mainland coastline. The Norse element, true to its Viking ancestry, appears to have established itself wherever good harbours and tillable land were to be found, for the vikings were husbandmen as well as seafarers.

The Pictish element seems to have been left in undisturbed possession of the more barren and hilly regions, as they are found to predominate in Harris - the most barren and rocky of the Outer Isles, - the higher parts of Skye, Mull and the Mainland.

The Irish Celts seems to have scattered over the Argyllshire Islands and Mainland. They are the least distinguishable locally, of all three original types.

I have heard it repeated more than once that the red-haired descendants of the Irish Celts are the most susceptible to tuberculosis of all the South-West Highland strains, but so far as my experience goes I have not been able to accept the statement unreservedly. I am inclined to think that it is merely a question of which racial element predominates in any given region, as the same statement is applicable in respect of fair-haired people, for instance, in Lewis.

To thoroughly understand the present social and economic/

economic status of the inhabitants of the rural Highland and Island districts, it is necessary to hark back to the beginning of the Eighteenth Century.

Few people realise how short is the history of our much-vaunted Western civilisation; still fewer ever reflect upon the rocky and tortuous path along which humanity has struggled to attain emancipation from a semi-barbarous social state. The defects of our modern social organisation are known and freely descanted upon by the man in the street to-day, but it is fairly safe to asseverate that the ethics of social progress are as grossly misunderstood as the evolution of social conditions is ignored or forgotten.

Picture the conditions under which rural inhabitants lived in Scotland at the beginning of the 18th Century. In the year of "the '45", Inverness, the capital of the Highlands, was a collection of low, rush-thatched cottages each consisting of one or two apartments, devoid of even the crudest sanitary or hygienic arrangements. The same roof sheltered man and beast and it was the exception to find the lodging of either to be differentiated by a "but-and-ben". These conditions of life obtained generally throughout the Highlands and Southern Uplands of Scotland. In the remoter island districts of Scotland and poorer districts of North-western Ireland, these conditions, somewhat ameliorated, persist to this day.

These remote backwaters have been left practically undisturbed by the flood-tide of social development which set in with the dawn of the Industrial Age, in the first half of the nineteenth century.

The years between the '45 and the coming of the industrial era must have been a critical period for the destiny of Highland communities. Culloden Moor witnessed the death of the clan system and ended the centuries-old ~~eye~~ struggle of Celtic feudalism against the forces of constitutional development.

The transformation after Culloden was not confined to political issues. Economic conditions in the Highlands underwent an evolutionary change. Hitherto, the survival of the clan-system of feudalism had protected the Highlander from the imposition of state and local taxation. He would have been a bold gauger indeed who would have ventured into the wilds of Lochaber or Moidart to collect dues for the Royal Treasury! Following the '45, however, Highlanders became amenable to the full privileges - and burdens - of British citizenship, with the result that their economic status, sufficient in the days gone by, failed to meet the requirements of the new order of things.

Depopulation of Highland rural districts set in - the inevitable result of economic pressure. At first the surplus man/

man-power enlisted into the Army in great numbers - it is on record that 1600 Skyemen stood in the British ranks at Waterloo - later, emigration to the Colonies, more particularly Canada, afforded permanent settlement for the excess of population. More important than either of these was the demand for labour in the rapidly growing towns of the Lowlands, which by the first half of the nineteenth century had begun to propper in the prosecution of textile industries.

A further cause of the depopulation of Highland rural areas is to be found in the potato famine of 1846. The resident crofter-population suffered great miseries, and the provision of Government aid did not suffice to stem the great rush of emigration which followed. Estate-proprietors, seriously embarrassed by the depreciation in lettable value of their Highland estates, caused numbers of their crofter tenants to be evicted and put the land thus freed under sheep. In Argyllshire and Sutherlandshire, this somewhat heartless procedure was effective in driving thousands of peasants from their ancient holdings to seek a home across the sea.

At the present day, the economic law which compels the young adult Highlander to emigrate is no whit abated. One of the most vivid memories of pre-war days is the departure from/

from the wharves of Liverpool and Glasgow, of crowded emigrant transports each bearing away its quota of lusty emigrants from the land of "bens and glens".

The tradition of emigration is the effect, rather than cause, of those economic factors which engender and perpetuate the stagnation of social progress in the Highlands today.

The bulk of Island and West Coast peasantry are crofter-fishermen - by nature a hardy, intelligent and thrifty race, who make the best of the too-often deplorably unhygienic environment in which they are constrained to pass their days. During the last two or three decades, a great deal of improvement has taken place in regard to housing conditions in those communities specially favoured by proximity to railway and steamship lines of communication. But the fact remains that a large proportion of rural dwellers, especially in the Outer Hebrides, exist under conditions of home environment but little removed from those of a century and a half ago.

This rough sketch of the social conditions, past and present, obtaining in the Highlands and Isles, enables us to appreciate their essential relation to the epidemology of tuberculosis in that area. We have to grasp the central fact that, some sixty or seventy years ago, tuberculosis, hitherto practically an unknown disease, began to assert itself, establish itself and finally, to assume epidemic proportions/

proportions of exceptional magnitude.

In treating of the non-prevalence of Consumption in the Highlands, McNab is careful to observe that he excludes from his categorical reference those "painful cases of natives of the Hebrides becoming affected while pursuing their avocations in the South Country, and, as a dernier ressort, have been sent home to benefit by their native air." This incidental reference on the part of the worthy practitioner constitues a fact of prime etiological importance and crystallizes our view of the manner in which tuberculosis gained an entrance into the remote districts of the Western Highlands and Isles.

Tuberculosis, as is well known, cannot originate de novo. The disease is propagated by the victim of an active tuberculous lesion of the lungs. Thus, it may be spread wherever its host may travel - a "carrier" infection in the strictest sense. How is this fact to be read into the riddle of the tuberculosis problem in the Western Highlands and Isles?

MacNeill, Macdonald and others have recorded their belief that the appearance of tuberculosis in the remoter Highland areas coincides with the opening-up of rapid and easy communication with the large centres of population in the South, where the disease could only too easily be acquired/

acquired by healthy rustic youths obliged to work and live at close quarters with active sources of infection. There can be but little doubt that this is a reasonable and sufficient explanation. Emigration of Highland youths occurred as we have seen, many years before the era of cheap and rapid transit in the Highlands, but this latter fact, in itself, may explain why such as acquired tuberculosis were unable, or unwilling, to make the arduous return journey to the distant shieling.

Once the disease gained an entrance to the overcrowded and insanitary Highland dwelling, nothing further was necessary to ensure its spread to other members of the family circle. The soil, human and material, was pre-eminently favourable to the exertise of its baneful activities.

Macdonald lays stress upon the continuous stream of infection from the large cities, which constitute "breeding-places of infection" for the rural areas whence they draw no small part of their increment of population. The annual emigration of fisher-girls from the Islands - particularly Lewis and Barra, - to the East Coast fishery ports, provides an illuminating example of this yearly introduction of fresh strains of infection. These fisher-girls are obliged to work for long hours on the open wharves, exposed to the rigours of East Coast winters. Their sleeping accommodation is often/

often deplorably insufficient, their meals scantily varied irregular and ill-cooked - little wonder then that, in addition ~~teeh~~ to their hard-earned 'siller' they frequently carry home the virus of consumption.

The excessive prevalence of phthisis in the Western Highlands and Isles has given rise to the popular conception that the Highlander is racially predisposed to the disease. This opens out a wide field for speculation. Personally, I repudiate the importance attached to ethnological considerations per se. One who happens to have 'Mac' to his name is not thereby endowed with a special predilection for contracting tuberculosis. But as he is, nine times out of ten, in the area with which we are dealing, a rural dweller living in a grossly unhygienic and contaminate milieu, he is, ipso facto, predisposed to the risk of massive infection and serious pulmonary involvement.

Notwithstanding, there is an aspect of the question of susceptibility to disease, on the part of the native Highlander, which calls for attention. It is a fact which I have observed particularly in Fever Hospital practice, that the ordinary zymotics pursue a course of unusual severity in native Highland subjects. One has vivid recollections of the havoc caused by measles among Highland Territorials quartered in Bedford in 1914. Zymotics occurring in city-dwellers/

dwellers seldom give rise to the severe toxaemic symptoms which have been observed to characterise their occurrence in virgin soil, such as for instance aboriginal and native tribes. The most feasible explanation seems to reside in the gradual acquirement of specific immunity by passage of the virus through successive generations - but here again we are on debatable ground. Whatever biological variations may have influenced the pathogenicity of zymotic diseases, we are not justified in assuming, by parity of reasoning, the occurrence of a parallel in the case of tuberculosis. Metchnikoff's theory of gradual immunization on a communal scale stands to be refuted by the disparity between the mortality-rates of the various groups of the older civilizations. In 1915, the figures per 100,000 were:- Scotland, 111; England, 116; Germany, 142; Ireland, 178; France, 179. In Russia and Austric the figures were doubtless still higher.

Clive Rivière endeavours to bolster up the theory of Metchnikoff by attributing the immunizing process to the influence of bovine infection. He points out that a high incidence of abdominal tuberculosis (presumably of bovine origin) and low phthisis mortality-rate is characteristic of Great Britain as compared with European countries and infers a causal relation between the prevalence of infantile tuberculosis/

tuberculosis of bovine origin and a low phthisis mortality. Be that as it may - we are unable to lend testimony to the belief that the native Highlander is inherently susceptible to tuberculosis of a severe and intractable type. One's own experience has, on the contrary, inclined to the conviction that the native Highlander possesses a relatively high degree of immunity - not, certainly, towards infection - but towards the disease once it is established in the organism.

On first commencing the study of tuberculosis in the Outer Isles, one was forcibly struck by the enormous amount of pulmonary tuberculosis present in a chronic stage and the relatively low mortality from the disease. Further observation revealed the fact that the disease, generally speaking, was of a mild type, exhibiting a strong tendency to spontaneous arrest by fibrosis. The number of adults affected with chronic fibroid phthisis was truly remarkable. In the ordinary routine of general practice, it was exceptional to come across a chest which did not exhibit the signs characteristic of tubercular mischief. Associated with this, there was a remarkable scarcity of tuberculosis of gland or bone in young children.

The unusual tolerance to the diesase was all the more remarkable/

remarkable in view of the outrageously bad housing conditions which predominated. Two-thirds of the people lived in the traditional clachan type of dwelling, which is now seldom seen on the Mainland and which has already been described as the epitome of unhealthy living environment.

The Report for 1920 of the Medical Officer of Health for Lewis is highly instructive of the position in that district with regard to tuberculosis. Twelve per cent of the total mortality from all causes was due to tuberculosis. Thirty per cent of the total deaths were uncertified, and there is good reason to believe that a considerable portion of these were due to phthisis. Deference to the sentiments of relatives accounts for a large proportion of uncertified deaths in Highland rural areas, where feeling is apt to run strong on the matter of consumption. In Lewis out of a population of under 25,000, no less than 118 deaths were due to all forms of tuberculosis in the two years 1919-20. This is five more than the number occurring during the same period in the County of Argyll with a population of slightly over forty-one thousand.

It is a remarkable fact that the more remote the locality and the more backward the state of social progress, the more serious the incidence and mortality from tuberculosis. Thus Lewis and Harris show the highest incidence and/

and death-rate of all the insular districts. The insular districts, as a whole, give higher rates than the mainland districts. The difference is the measure of improvement in social and economic conditions enjoyed by the latter, particularly in the matter of housing facilities.

A study of the clinical types of the disease in the West Highlands and Islands reveals the fact that their is a disproportionately large element of chronic phthisis as compared with acutely progressive and fatal forms. It is difficult to account for either the preponderance of the chronic type or the low morbidity which characterizes it. Dr. Porter is inclined to associate both with the cause of absence of ordinary rickets in Island children i.e. the use of a dietary rich in fat-soluble vitamines. But the same phenomenon is conspicuously absent in other northern districts, such as Caithness, where rickets is unknown, and the average diet probably richer than that in Lewis.

The relative infrequency of scrofulous glands, tabes mesenterica, etc. is doubtless due to the fact that dentition is good in Island children, each family keep their own cow and bovine tuberculosis is comparatively uncommon. But one cannot homologate the excessive prevalence of a type of pht isis characterized by low mortality with any known theory of immunity - natural or acquired. Neither can/

can recourse be had to the pleasing explanation of variation in virulence of the infecting agent, as acute cases may occur in a family in which the other members show a strong tolerance of the same type of infection. We are left, then, with the factor of specific individual resistance, which appears to be possessed to a considerable degree by the inhabitants of the Highlands and Isles. Viewed in this light, the prevalence of phthisis exhibiting a low mortality is probably due to the ideal conditions which exist for massive infection by direct inhalation, the subsequent course of the disease being mitigated by the high degree of resistance possessed by the infected individuals.

Exactly why such special features of reaction towards tuberculous infection should occur in these districts has, in my opinion, yet to be determined. As a matter of conjecture, one might venture the opinion that such reaction is a necessary phase in any community in which the curve of epidemicity is on the ascendant. The maximum morbidity of phthisis in the Western Highlands and Isles occurs in the age-group 15-25. If a curve is plotted of the death-rates under the various age-groups, it is seen that the maximum occurs in that age-group (15-25) while the decline towards later ages is interrupted by a small rise at the age of 45. Excluding this latter rise, the curve closely resembles/

resembles those for Shetland and Ireland, indicating that the disease in all three districts chiefly affects young adults.

According to Dr. Brownlee, who has recently done valuable work on the epidemiology of phthisis in Britain, the ~~British~~ Irish epidemic of "young adult" phthisis reached its maximum some 30 or 40 years later than did the English epidemic. It appears that a somewhat analogous relation exists between the epidemic wave in the Western Highlands and Isles and that in Scotland generally. As the maximum death-rate from phthisis in Scotland occurred during 1870-71, we may therefore regard the epidemic of "young adult" phthisis in the Highlands and Isles as only now approaching its maximum and likely, in the near future, to show a definite tendency towards decline.

In dealing with the future progress of tuberculosis in West Highland and Island districts, the fact must not be lost sight of, that in all probability the worst has been passed and that, henceforth, the passage of time will bring further improvement. At the same time, the exercise of preventive measures must in no wise be suspended - rather should efforts be intensified in order to increase the efficiency of anti-tuberculosis measures such as they exist.

The/

The operation of anti-tuberculosis measures in the Western Highland and Islands is attended by difficulties naturally incident to an area in which the population is widely distributed and the means of communication limited. From an administrative point of view, the factors of space and time involved impose definite limitations on the value of methods approved in urban communities. The difference is still more marked in the case of executive measures. Take, for example, that admirable unit of control, the Tuberculosis Dispensary, which has proved its worth in every urban and centralized rural community into which it has been introduced. The Dispensary System, for reasons just stated, is quite unworkable in Highland districts, with the possible exception of those immediately adjacent to the burghs.

The psychology of the Highlander must be taken into account, as well as the material factors pertaining to the problem of prevention in this area. Any infectious disease is classed as "fever" and looked upon with horror and loathing - by the native Islander especially. I have seen a strong picket of men barring all exits from a hamlet visited by typhoid fever. So strict was the isolation imposed, that the unfortunate relatives of the stricken ones were not allowed to go to the local store for/

for provisions! In the same district a girl suffering from measles was bolted and barred in a small room and was handed the bare necessaries of life through a small window. The doctor visiting the case had perforce to use the same means of entry on the occasion of his first visit.

Consumption, on the other hand, is viewed somewhat in the light of a punitive visitation of the Almighty, and held to be a family odium. The utmost reluctance is frequently displayed towards invoking the physician's aid, and the exercise of diplomacy is called for in the attempt to induce these patients to accept institional treatment. Strong resentment may even be aroused against the practitioner who certifies the death of a near relative to be due to consumption. It is extraordinary what patience the relatives display in nursing and tending a confirmed consumptive. Their indifference to the danger to themselves, which results from the continued presence of a consumptive in their midst, is no less remarkable. The combination of ignorance and superstition is a factor to be reckoned with in preventive measures in the Western Highlands and Isles, more especially the latter.

The difficulty of supervision of individual cases, examination of contacts, regulation of domiciliary treatment and after-care of patients, is so great in these scattered/

scatted communities that it is impossible to expect its being carried out by a specially appointed officer. The work, therefore, largely falls upon the local practitioner, who receives,as matters stand at present, but scanty encouragement to interest himself in active preventive measures.

The accommodation available for the institutional treatment of consumptives in the West Highland area is quite inadequate. In the four counties of Argyll, Inverness, Ross and Sutherland, there are only 80 Sanatorium beds available for a population of well over a quarter of a million. In addition, it may be stated that in certain districts a few beds have been set aside in the Infectious Diseases Hospitals for the reception of advanced cases of phthisis, but very little use is ever made of such accommodation. The fact is that patients regard the suggestion of removal to "hospital" as tantamount to a death-sentence. Strange to say, this ban is not extended to the Sanatorium. I have seldom experienced a blank refusal of the offer of Sanatorium treatment. Patients demur frequently, but I have had little difficulty in convincing them of its value, after listening to and explaining away their doubts. So far, Argyllshire is the only West Highland County which has adopted a Tuberculosis Scheme. In the remaining counties such/

such measures as exist for the prevention and treatment are vested in the Public Health Committees of the several Local Authorities.

In Lewis, a Sanatorium of 20 beds has been erected by the Red Cross Society at Stornaway. In Inverness-shire the County Council possess a Sanatorium of 28 beds, at Fort Augustus.

The failure of these Northern Counties to adopt comprehensive schemes for the control and prevention of tuberculosis is due to no lack of appreciation of the gravity of the position occupied by the disease within their areas of administration. Rather have the local authorities been appalled at the prospective cost of any regular linking-up of their scattered communities into a special health-service district. Still more, the doubtful success which had attended large expenditure in similar experiments elsewhere made it less easy to ignore the initial handicap imposed by the topographical peculiarities of these districts.

In view of the clamant need for economy in public expenditure at the moment, and the prospect of lean years for some considerable time to come, it is unlikely that much progress will be made in the direction of setting up new machinery for the more effective control of tuberculosis in the Highlands and Islands.

The Tuberculosis Scheme adopted by the County of Argyll has now been in force for almost seven years. A short résumé of the experience gained during this period will afford useful data on which to base the future outlook of anti-tuberculosis measures in the West Highlands and Isles.

It is necessary to point out that, during the war years, the effective prosecution of the Scheme was decidedly hindered by the abnormal conditions prevailing throughout the country generally. We must therefore, in our criticism, have due regard to the influence of reduction in personnel of the staff, and the stress of war-time restrictions upon local authorities in general.

The object of any Tuberculosis Scheme is two-fold, firstly to bring the existing disease in the area under control and secondly, to eradicate the disease so far as that is possible of attainment. The first objective is a question of organisation and administration, whilst the second involves the exercise of preventive and curative measures with the incidental co-operation of those factors, social and economic, which tend to produce a higher standard of living.

An excellent guide to the efficiency of control is afforded by the number of notifications of cases of the disease/

disease and the stage of the disease at which in each case the notification is made.

In 1920 the notifications of all forms of Tuberculosis exceeded the mean number for the previous five years by forty-five per cent. This improvement in notification is satisfactory as it indicates that the vitality of the scheme is recovering from the stagnation of war-time.

As in previous years, however, the majority of cases notified were in an advanced stage of the disease. This has been a characteristic feature of notifications of pulmonary disease, and one which brings into prominence the essential weakness of the preventive side of the Scheme.

It is obvious that, so long as cases are not brought to the notice of the authorities at a reasonably early stage, the practical utility of both curative and prophylactic measures is largely discounted.

Improved facilities for early diagnosis of pulmonary cases are necessary. The essence of the problem lies in the fact that the facilities provided in the present scheme are modelled too closely upon those found suitable in urban communities. In the latter, a whole time tuberculosis officer with several Dispensaries under his charge can keep in constant touch with his work and follow up contact-cases with little loss of time. But in Argyllshire, it is entirely different./

different. The executive Tuberculosis Officer, who is also assistant Medical Officer of Health and therefore a part-time official so far as Tuberculosis is concerned, is barely able to complete a circuit of his widely-scattered area more than once in twelve months.

Local parish Medical Officers of Health receive a remuneration for work in respect of tuberculous cases in their area, but this remuneration is so small that it does not stimulate the making of early diagnosis in pulmonary cases. These officers are busy general practitioners. To their efforts a large measure of the success attained by the Scheme is indubitably due - but they cannot be expected to play the part of public philanthropists to the extent necessary for the efficient seeking-out of early cases.

Coming to the consideration of facilities for treatment, it is apparent from a study of the excellent Reports of Dr. MacDonald, Sanatorium Medical Officer, that the class of case seeking admission to the Sanatorium is, generally speaking, more suited for isolation and segregation than for curative effort. Out of a total of 425 cases admitted for treatment over a period of twelve years, only 89 could be classed as "Early Cases," (stage 1. Turban's Classification), while 188 were "moderately advanced/

advanced" (Stage II.) and 148 were "Advanced" (Stage III.) The result of treatment was highly satisfactory from the therapeutic point of view. One hundred and fifty-five were discharged with disease arrested, 79 were much improved, 36 improved, while 52 showed no improvement, 77 died and 26 remained under treatment.

The main function of a Sanatorium supplying a community in the Western Highlands should be the inculcation of the principles of the personal hygiene of the consumptive patient. This, in my opinion, is more important than the cure of individual cases, as it has been abundantly proved that a patient may recover equally well at home, if placed under suitable conditions. To this end, it is desirable that as many cases as possible should be passed through the Sanatorium, and this, in default of increased accommodation there, can best be achieved by limiting the period of residence of each patient to a fixed period of three or four months. This method has been adopted in Germany recently with the best results.

The fact has got to be remembered that a great deal of ignorance exists among the laity as to the relation between bad ventilation, etc. and the incidence of lung disease. Naturally, one has found that it is among those who have least regard for the ordinary tenets of hygiene that pulmonary tuberculosis is most rampant. In Mainland communities where/

where the standard of housing is much above that in the Islands, a great deal can be, and is being, done to utilize the facilities for domiciliary treatment of consumptives.

In the future, large hopes must be based upon the development of the practice of Domiciliary treatment. In ~~scattred~~ Highland Rural areas, where efficient supervision of domiciliary treatment and after-care cannot reasonably be carried out by a central official, the onus of these duties must be undertaken by local medical practitioners assisted by district nurses. This is another reason for insisting upon the cardinal importance of the general practitioner in the role of local tuberculosis officer.

In districts such as the Long Island and certain parts of the West Highland mainland, where housing conditions are so inferior that useful attempts at making the best of things are positively excluded, the only remedy lies in a radical reform in housing. The collapse of State-aided housing-schemes has checked the rising hopes of communities interested in them, but, where Government inspiration has failed, there are hopes that private enterprise will succeed.

It is too soon, at this stage, to envision the industrialization of the Highlands, and still more so to contemplate the Utopia which would arise from the laying-out of ideal garden-cities in rural districts of the West Highlands and Isles. But the era depicted has already begun. The British/

British Aluminium Company's model village at Kinlochleven, in Argyllshire, forms a striking contrast in amenity and salubrity to the neighbouring, old-world, typical Highland village of Ballachulish, which is a veritable nest of tuberculous disease. The same Company have a scheme on foot for industrializing Lochaber. In Lewis and Harris the magnanimous schemes of Lord Leverhulme are fraught with a happy destiny for the Islesmen, who have the unenviable reputation of being the worst-housed community in Scotland.

Along the lines roughly sketched in the foregoing, the future campaign against tuberculosis will be fought. Unceasing and intelligent endeavour to make the best of existing facilities, personal and material, preventive and curative, is the mandate for those entrusted with the direction of health-measures.

The lessons of experience must not be disregarded. No taint of ultra-conservatism must be allowed to perpetuate obsolete and uneconomical methods or stand in the way of healthy reconstruction.

Turning, in conclusion, to the consideration of the broad problem - of which that wherewith we are immediately concerned is but an insignificant unit - what has the future in store for the national crusade against Tuberculosis? Despite the difficulties that must be faced, is there cause for other than optimism?

We are fortunate today in that it is possible to look back upon thirty years of honest endeavour, fearless experiment and unstinted application to the task of mastering the "white man's scourge." The phenomenon of a steadily declining phthisis death-rate now stands revealed as the result, not, certainly, of special human effort alone, but rather in combination with those contributory etiological factors which we now recognise and homologate in practice. In the successful prosecution of anti-tuberculous measures Britain today leads the world. We are on the right lines and the task is well in hand. Encouraged by a benevolent and sane legislation, and inspired by the conscious fulfilment of a national trust, authorities responsible for the conduct of anti-tuberculosis measures have a clear-cut path of duty before them. Above all, Time is on the side of the forces of Betterment, and the future is bright with hope.

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